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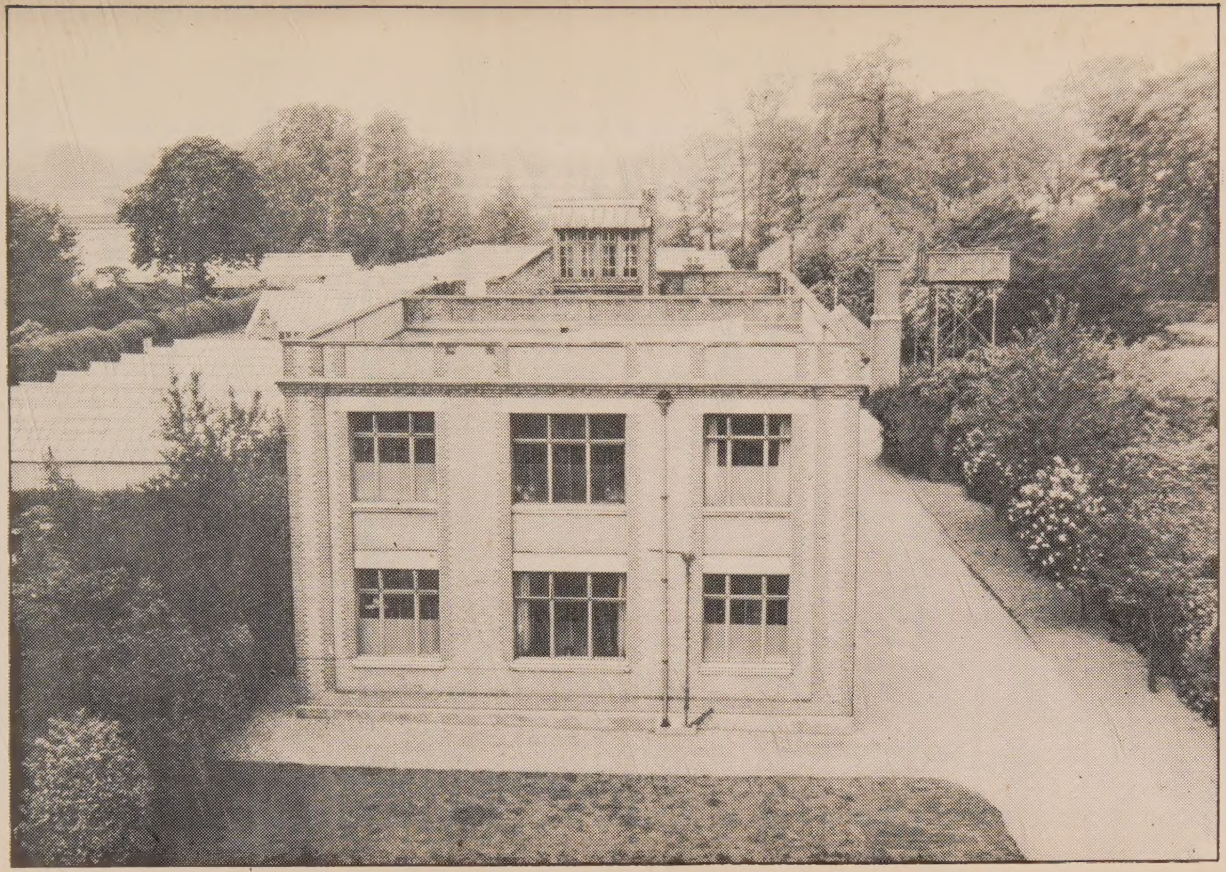

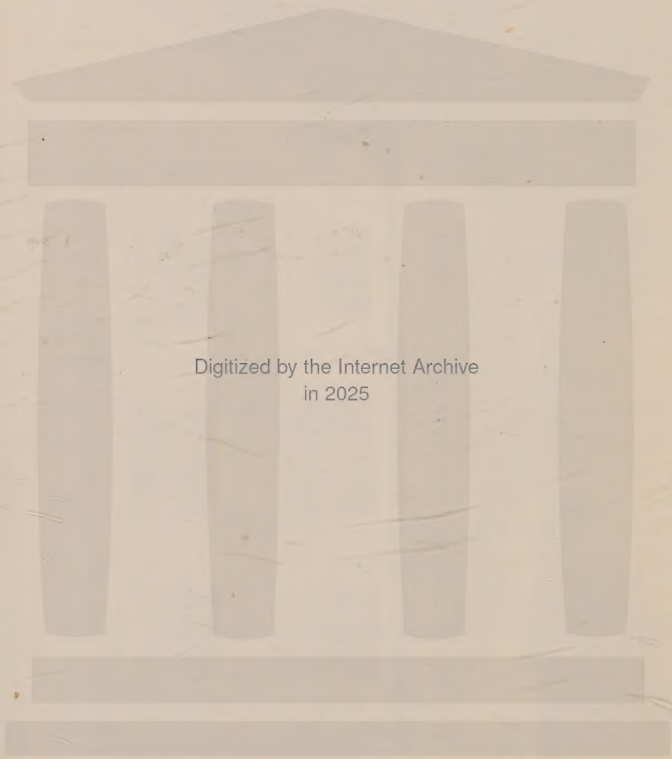

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Introduction.

THE end of the first year of the Second Great War finds the Cheshunt Research Station continuing its work for the Glasshouse Industry undismayed by enemy action. Long range research has been temporarily suspended so that the staff may apply its time in assisting growers to adapt themselves to the changed conditions. The need for increased food production necessitated some reduction in the acreage devoted to flowers, and up to October, 1940, flower growers were required to turn over 25% of their flower houses to the cultivation of an approved food crop. After that date the proportion was increased to 50%, unless the grower was prepared to devote all his glasshouses to food production between March 15th and September 15th; when no further reduction beyond the original 25% of the 1939 crop would be demanded. This change over from flowers to food crops, and the need for securing maximum yields from all nurseries, meant that growers would require just the kind of advice which the Research Station is well qualified to give. It was decided that the services of the staff should be available to all growers, and that the method of direct contact by visits to nurseries should be employed to an extent impossible in peace-time, when research work in the laboratories occupied the whole time of the scientific workers.

On November 28th, 1939, the offices and a small advisory team were transferred to premises at 129, Brighton Road, Worthing, Sussex, so that more attention could be paid to nurseries on the South Coast, and first hand information obtained of the growers' problems and needs in that area. The party returned to Cheshunt on August 12th, 1940, after spending a profitable nine months in Sussex.

During September, 1940, Dr. O. Owen, accepted the task of contacting growers in North Wales, where his knowledge of local conditions enabled him to complete a successful tour of glasshouse nurseries. During October, Mr. E. R. Speyer undertook similar duties in Northumberland. In each case, useful information was obtained of local conditions, and the growers welcomed our representatives in a most cordial manner.

During October, also, Dr. I. W. Selman assisted the War Agricultural Executive Committee of the Isle of Ely with the census of glasshouse properties in that area. Dr. Selman was glad to have the opportunity of assisting the authorities, and at the same time made useful contacts with local growers. Mr. W. H. Read assisted the Essex County War Agricultural Executive Committee with their census during October and November. Growers in this area are familiar with the work of the Cheshunt Station, but Mr. Read's visits should have done much to stimulate interest in this Station.

It is pleasing to be able to record in all cases the friendly co-operation of the County and Provincial Officers. These gentlemen did all they could to assist us to meet the growers, and study their problems often at considerable inconvenience to themselves. These efforts comprising as they do only a small scale attack on the problem, have shewn very clearly the need for equipping a research station with a sufficient number of advisory officers to cover the whole country, for only in this way is it possible to carry the results of research to every grower, and so improve the whole status of the industry for which the work is being done.

In 1941, it is hoped to penetrate to other districts until the whole country has been covered.

Current Investigations.

In view of war-time conditions and the shortage of sulphate of potash an experiment was started to compare the effect of muriate of potash with that of sulphate of potash, arranging six plots of each. The results shewed a slight

decrease in yield from the muriate, in this, the first year of the experiment. The treatments will be repeated on the same plots for at least three years.

In other houses, the effect of omitting stable manure, base or top dressing fertilisers was tested against completely manured plots. The highest yield was obtained where all three treatments were applied. The omission of stable manure reduced the yield slightly more than the omission of a fertiliser mixture.

In view of the war, no cucumbers were grown in the cucumber houses. Instead they were used for tomatoes, and the variety Potentate (virus free) was used. The high average yield from the four houses of 47 tons per acre was obtained.

Cheshunt Early Giant lettuce was grown as a Winter Crop before tomatoes. As usual the results were highly satisfactory.

During the past four years, some observations upon the effects of adding selenium to soil as a control for Aphids and Red Spider-mite have been published by American scientists. In a series of experiments upon tomato plants grown in pots at Cheshunt, both a prolonged immunity from infestation by Red Spider-mite and a very considerable mortality of mites upon plants infested prior to application have been obtained by means of single applications of sodium selenate.

Owing to the poisonous nature of selenium salts much investigation is still required, especially to ascertain if the substance is conveyed through the plant to the ripening fruit.

Cane molasses was found to be an adequate substitute for treacle in the poison-bait commonly used for trapping Tomato moths in jars. Beet molasses was not attractive to the moths.

A comparison of the number of moths confined in cages killed after feeding upon baits containing sodium fluoride, sodium arsenite and thallium sulphate respectively, indicated that sodium fluoride was the most effective poison.

Dichlorethyl ether, a liquid known to be lethal to wireworm, was so injurious to tomato plants grown in the ground, and its persistency in the soil so great, when watered into the soil even in very small quantities, that the possibility of its use appears to be precluded.

A study of the life-history of Angle-shades Moth (*Brotolomia meticulosa* L) has been completed, and an account has been published in the Annals of Applied Biology.

Many proprietary insecticides, fungicides and sundry products have been tested and samples of formaldehyde, tar acid products, etc., have been examined for members of the Association.

Root rot of the French bean in glasshouses has been investigated. Many organisms have been isolated from the diseased tissue, but the only parasite found was a species of *Fusarium*, probably *F. solani* variety Martii forma 3. The diseased condition produced experimentally, however, is not so severe as in commercial glasshouses, and this may be due to secondary infection with other organisms in the second instance.

Experiments have shewn that where the young plants are grown in bottomless pots and are planted out in the soil without removing the pots, the stem-base is protected: the method is promising as a control measure on nurseries where this disease is troublesome.

An experiment has been carried out on a well manured soil, to determine the effect of tomato mosaic and "streak" viruses on the yield and quality of tomatoes grown to five trusses. Plants infected when the fifth truss was in bloom produced up to 28% more fruit than those infected when the first truss was in bloom. The reduction in yield can be

accounted for by a reduction in (*a*) the number of flower buds produced, and (*b*) the number of fruits formed. Closer attention to cultural conditions when mottling first shews on the top-leaves, does much to reduce losses from these virus diseases. Light dressings of soluble nitrogenous fertilisers tend to maintain flower bud differentiation, and careful control of atmospheric humidity assists setting.

A serious case of mushroom deformation almost ruining the first flush in several large mushroom sheds, has been investigated. The damage was attributed by the grower to treatment of bed boards and other wooden parts of the house with a mixture of creosote and petrol. Although the vapours from freshly creosoted wood proved capable of injuring the mycelium and young mushrooms forming in the casing soil as well as browning the caps of larger mushrooms, deformation was not produced in any of the experiments with creosotes, petrol, or mixtures of the two.

Severe scorching of cucumber, bean and tomato foliage was traced to the presence of sodium carbonate in the water used for overhead damping.

A large scale experiment on the growth of tomatoes and cucumbers in nutrient solutions was conducted on a local nursery. The yield of fruit obtained was much lower than that from comparable plants grown in the soil.

In the chemical department the greater part of the work has consisted of the routine examination of soils and fertilisers and what may be termed fertiliser substitutes. There has been a decided increase in the last named on account of prevailing circumstances. Of particular interest has been the number of samples of charcoal and wood ash. Actual analyses have shewn a wide variation in composition ranging from 0.6 per cent. to 16.1 per cent. pure potash. In one or two cases the price asked by the suppliers has been very high and has borne no relation to the actual values of the materials offered. Several samples of nitrogenous materials have also been examined

and growers are reminded that with new and untried materials analysis still constitutes a good guide as to their value.

Several experiments have been carried out to compare the effects on tomatoes of muriate of potash and potash salts respectively with those produced by sulphate of potash. Preliminary results indicate that potash salts can be harmful, but, as already reported, muriate can be used in place of sulphate if the soil and water supply are reasonably free from common salts and chlorides generally.

Experiments have also been conducted to examine the claims made that the vitamin factor B_1 has a beneficial effect on plant growth. Results indicate that the germination of tomato seeds is accelerated by this treatment but that in later life the plants are little affected, provided they are grown in a good compost. It is suggested that the material used in the compost may contain supplies of the vitamin adequate for the plant.

The problem of making glasshouses less conspicuous from the air was investigated, both as regards true camouflaging to make them indistinguishable by day and night and also, in a simpler form to prevent reflection from the roofs of glasshouses of light from the moon or searchlights. Effective camouflage reduced the light within the glasshouse by at least 60% whilst a loss of about 25% resulted from any treatment reducing reflection sufficiently to be considered effective. Proprietary products were included in these tests but many were impractical on account of their cost and the difficulty of removal when no longer required.

DIRECTOR'S REPORT.

1. Experimental Results of 1940.

1. Tomatoes.

The practice of grading the tomato fruits from the experimental plots, adopted in 1921, was continued:—

A.—"Pinks" number 5 to 7 and "Pink and White" 8 to 10 to the lb. These are the best quality of fruit in size, shape and colour; "Pinks" being slightly larger than "Pink and Whites."

B.—"Whites." These fruits are of good colour but smaller than "Pink and White."

C.—"Blues." This grade consists of fruits of good colour but larger and more irregular in shape than Grade A.

D.—"Roughs." Small mis-shapen fruits about the size of cherries.

E.—Blotchy fruits which ripen irregularly.

F.—Fruits shewing Blossom End Rot.

G.—Fruits shewing the lesions of Stripe Disease.

H.—Fruits shewing "Green Back."

(a) House 2. Root restriction experiment.

This experiment consisted of planting tomatoes in cardboard containers, 8 in. by 8 in. by 8 in., as in previous years, and comparing the crop yield with that from plants growing in the ground. The plants grew well and produced a good crop, but there was no difference in yield between the two treatments. This is probably due to the excellent weather conditions, which induced a well-balanced growth without the assistance of root restriction, and once more suggests that the usefulness of cardboard containers depends upon the fact that they can be used to prevent unduly soft growth during the first part of the season. They are, of course, valuable also as a means of providing the young plants with a good rooting medium on worn out soils, and for lifting them further away from an injurious subsoil. To save paper, the tabulated results are not being printed.

(b) Houses 3, 4 and 5. Manurial experiment.

In House 3 two plots received stable manure, 15 tons per acre, and a base fertiliser 1½ tons per acre, while in two others the fertiliser was omitted. Top-dressings were applied to all plots during the season as the plants required it. The results are given in Table 1, from which it will be seen that the omission of the base fertiliser reduced the yield appreciably. This experiment was arranged to determine if, in time of war, it is safe to omit the base fertiliser, and so effect a saving in the amount of fertilisers used. The results suggest that both horse manure and base fertilisers should be used as long as they are available.

In House 4 the effect of applying fertilisers only as a top-dressing and as a base-dressing respectively was tested. As in previous years, it seemed unimportant whether the fertiliser was applied before planting or as a top-dressing after planting, because, as can be seen in Table 2, the crop yields are identical, when stable manure was omitted. Obviously, if the choice had to be made, it would be best to rely upon a top-dressing, because in this case feeding could be regulated to suit weather conditions.

In House 5, all fertilisers were omitted from two plots, while two received stable manure and top-dressing treatment. The results, Table 2, shewed that the omission of all fertilisers reduced the yield considerably, and in a sunny year like 1940 it does not pay to attempt to grow tomatoes without enriching the soil with fertilisers.

(c) Houses 7—9. Sulphate of potash v. Muriate of potash.

In view of the possible shortage of sulphate of potash it was arranged to compare the effect of the muriate with that of the sulphate in these three houses. The arrangement gave six plots in each series.

The results set out in Table 3 indicate that the total yield of tomatoes is slightly less from the plots treated with muriate of potash than from the sulphate. Apart from this no difference was observed in either the quality of the fruit or the colour of the foliage.

(d) House 1. Variety Trials.

In the variety trials, the results of which are given in Table 4, three of the top four varieties were two strains of Potentate and Duker, a Dutch variety which resembles Potentate. The other was Carrick, which is grown largely in Scotland. The variety at the bottom of the Table, Cooper's Ideal, shewed the lowest proportion of coarse fruit, and is an

Table 1.

Variety—Ailsa Craig.

House	Plot	Treatment before planting	Crop yield in lbs. per plant							Total tons per acre	Average tons per acre	Average % blotchy ripening
			May	June	July	Aug.	Sept.	Oct.	Total			
3	2	Stable manure only	0·07	1·93	1·52	0·67	0·75	—	4·94	37·55	36·25	3·52
	4	,, ,, ,, ...	0·06	1·85	1·48	0·71	0·27	0·23	4·60	34·95		6·91
	1	Stable manure and base fertilizers	0·12	1·71	1·87	0·91	0·58	0·22	5·40	41·03	41·30	4·83
	3	,, ,, ,, ,, ...	0·02	2·04	1·75	0·95	0·71	—	5·47	41·56		3·47

Table 2.

Variety—Ailsa Craig.

House	Plot	Treatment before planting	Crop yield in lbs. per plant							Total tons per acre	Average tons per acre	Average % blotchy ripening
			May	June	July	Aug.	Sept.	Oct.	Total			
5	2	No horse manure, base fertilizer or top dressing	0·27	1·78	1·09	0·59	0·39	—	4·12	31·31	31·24	0·78
	4	" " " "	0·21	1·73	1·12	0·55	0·46	—	4·07	30·93		1·23
	1	Stable manure and top dressing but no base fertilizers	0·29	1·98	1·18	0·70	0·69	—	4·84	36·78	35·04	1·44
	3	" " " "	0·22	2·00	1·25	0·65	0·52	—	4·64	35·26		0·86
4	4	Top dressing only	0·14	1·31	0·85	0·68	0·52	0·42	3·92	29·79		3·05
	5	Base fertilizer only	0·10	1·44	1·17	0·63	0·36	0·26	3·95	30·00		2·77

Plots 1 and 3 have the same treatment. i.e., stable manure and top dressing but no base fertilizers.

Table 3.

Variety—E.S.1 (7 and 8); Ailsa Craig (9 and 10).

House	Plot	Treatment	Crop yield in lbs. per plant							Total tons per acre	Average tons per acre	% blotchy fruit	Average % blotchy fruit
			June	July	Aug.	Sept.	Oct.	Nov.	Total				
7	1	Potash in base and top dressing as Sulphate of potash ...	1·02	2·31	1·15	0·52	0·08	0·40	5·48	41·66		1·08	
	3	,, ,, ,, ,, ,,	1·09	2·74	1·29	0·55	0·14	0·41	6·22	47·28		1·76	
8	2	,, ,, ,, ,, ,,	1·08	2·96	1·66	0·92	0·28	0·38	7·28	55·33	50·78	1·37	1·46
	4	,, ,, ,, ,, ,,	0·83	2·98	1·63	0·80	0·25	0·42	6·91	52·52		2·03	
9	3	,, ,, ,, ,, ,,	0·64	2·97	2·08	0·93	0·22	0·48	7·32	55·64		1·09	
	4	,, ,, ,, ,, ,,	0·65	2·82	1·86	0·91	0·19	0·45	6·88	52·28		1·45	
7	2	Potash as Muriate of potash	1·17	2·62	1·14	0·59	0·14	0·40	6·06	46·06		1·65	
	4	,, ,, ,, ,, ,,	0·98	2·45	1·11	0·44	0·12	0·39	5·40	41·73		1·09	
8	1	,, ,, ,, ,, ,,	0·99	2·39	1·31	0·59	0·23	0·39	5·90	44·84	46·73	1·53	1·15
	3	,, ,, ,, ,, ,,	0·71	2·84	1·54	0·87	0·24	0·41	6·61	50·24		1·20	
9	1	,, ,, ,, ,, ,,	0·80	2·54	1·52	0·76	0·17	0·47	6·26	47·58		0·64	
	2	,, ,, ,, ,, ,,	0·79	2·65	1·56	0·86	0·22	0·49	6·57	49·93		0·76	

Variety Trials.

Table 4.

Variety	Crop yield in lbs. per plant							Total tons per acre	Quality of fruit : Percentage in each grade				
	May	June	July	Aug.	Sept.	Oct.	Total		A	B	C	D	E
Potentate (a)	—	1·69	2·40	1·44	0·47	0·54	6·54	49·70	72	4	18	2	4
Duker	—	1·19	2·25	1·13	0·28	0·80	6·37	48·41	65	7	20	4	4
Carrick	0·04	1·76	2·41	1·28	0·56	0·23	6·28	47·73	61	8	24	3	4
Potentate (b)	0·03	1·81	2·33	1·12	0·49	0·38	6·16	46·81	52	7	25	3	12
Sussex Nurseries No. 1	0·02	1·31	2·27	1·37	0·77	0·28	6·02	45·75	80	13	3	3	1
Salads Special	—	1·03	2·53	1·18	0·70	0·41	5·85	44·46	53	8	31	3	5
Essex Wonder × Market King	—	1·48	2·62	0·97	0·48	0·21	5·76	43·78	65	15	15	4	1
Electra	—	1·69	2·13	1·17	0·41	0·30	5·70	43·32	79	10	6	3	2
Vetomold	0·09	1·72	1·88	0·89	0·50	0·32	5·45	41·42	63	4	29	2	2
Comet (a)	—	1·59	1·94	1·12	0·40	0·36	5·41	41·11	78	10	9	2	1
Leaf Mould Resister No. 1	—	1·39	2·27	0·99	0·52	0·15	5·32	40·43	70	15	7	6	2
Coopers Ideal	0·02	1·27	2·23	1·08	0·38	0·26	5·24	39·82	86	8	3	2	1

excellent variety on some soils, especially those of a poor nature. On rich soils the growth is too strong. Two notable varieties are included in the trials, namely, Comet and Vetomold. Comet was a great favourite about the time of the last war and has probably never been surpassed for quality and flavour. Stocks became badly infected with Mosaic and the variety went out of favour. An attempt is now being made to rejuvenate it.

Vetomold is a new variety raised by Dr. Langford when working at the Vineland Horticultural Station of the University of Toronto, Canada. It is highly resistant to attack by *Cladosporium fulvum*. Our Canadian colleagues very kindly sent us seeds for trial in 1940, and we were able to distribute small samples to growers in different parts of the country. At its best Vetomold is a splendid variety and in Sussex some excellent crops were grown. The fruit is a little smaller than that of Potentate and it colours well. It proved resistant to leaf mould on all nurseries, but on some the crop was not outstanding. It is, however, a very promising variety well worth a trial by all growers, especially in districts where *Cladosporium fulvum* is dangerous.

(e) Tomatoes in cucumber houses.

At the outbreak of war it was decided not to grow cucumbers in 1940, but to concentrate upon producing the maximum yield of tomatoes in the cucumber houses. The variety chosen was Potentate (virus free seeds), because this variety favours a rich open soil and the warm moist conditions easily obtainable in narrow, low houses. About 4 inches of the old cucumber beds were removed, the remainder dressed with hydrated lime at the rate of 1 lb. per square yard and then dug into the base, leaving the top soil as level as possible. Four ounces of bone meal and 4 ounces sulphate of potash per square yard were forked into the top six inches.

The plants were planted out on March 19th, allowing three rows on either side of the centre path.

Two rows on either side of the path were removed after picking five trusses, leaving a single row along each wall. These plants were carefully tied on to the wires, originally used for the cucumbers, and kept tidy until the wires were well furnished with shoots. A very heavy crop of good fruit can be grown in this way and the average total weight of fruit at the beginning of December from the four houses was 47·6 tons per acre.

The space freed by removing the centre plants was filled up at the middle of September by tomatoes in 9 inch pots. For these, the seeds were sown at the middle of May in seed trays in a heated glasshouse. The young plants were taken on in size 60 pots, and after hardening off gradually were planted in 9 inch pots, using a good compost. This must be done not later than the first week in July.

Good turfy loam, limed at the rate of one 60 pot of hydrated lime per barrow load of soil, was mixed four barrow loads with one barrow load of good strawy horse manure, and the mixture reinforced by adding a 60 pot each of hoof and horn, bone meal, and sulphate of potash per barrow load of compost.

The plants were grown outside until the middle of September, and were given every attention with the object of forming four good trusses in each. They were staked with wooden stakes, fed and watered when necessary. In this respect it should be noted that they require more nitrogen than when grown under glass, to counteract the harder growth occasioned by outdoor conditions.

This method of using cucumber houses from September to January has been practiced for several years and has provided a supply of tomatoes up to the first week of the New Year. In time of war it should be tried by all growers whose plants are not worth retaining after the middle of September, and who therefore have room in the houses for the new crop

2. Lettuce.

As usual a crop of Cheshunt Early Giant lettuce was grown in the glasshouses for cutting in February. This crop, always valuable, is particularly so in war time. A great many growers took advantage of it last winter and reaped the benefit of handsome returns. Their success has spurred them on to further efforts and there is every prospect of ample supplies of glasshouse lettuce for the coming winter. The successful cultivation of this crop has been of great interest to the Research Station, for growers have proved the superiority of Cheshunt Early Giant for glasshouses over all other varieties during the autumn and winter.

Cheshunt Early Ball lettuce, also raised by the Research Station, is becoming increasingly popular amongst growers of frame crops, and in some districts it has proved a good variety for glasshouses also, particularly cold houses.

3. Mushrooms.

A crop of mushrooms was grown in the mushroom shed yielding an average weight of 2·2 lbs. per square foot. The investigation of casing soils was continued, comparing soil only with a mixture of soil and peat in equal proportions. The mixture gave a slightly higher yield during the first six weeks of picking, but the total weights were approximately the same. A brown variety was used.

2. Advisory Work in Wartime.

W. F. Bewley.

Life under wartime conditions has brought many changes to the civilian population and it is not surprising that the work of Research Stations has to some extent altered accordingly. The only reason for the existence of the Cheshunt Station is the need of the Glasshouse Industry for scientific assistance in solving the many problems which confront it, and as the result of consultations with the Ministry of Agriculture and the Agricultural Research Council it was decided to extend the practical advisory service by using such members of the Staff as could be spared from research for visiting growers all over the country.

The first big change was the removal of the Director, Office Staff, and an advisory team to the South Coast. Suitable premises were leased at 129, Brighton Road, Worthing, and the essential laboratory equipment was installed, so that the investigations of local problems could be conducted on the spot without the complication of sending material to Cheshunt for examination. The transfer was completed by 27th November, 1939.

The object of this change was to make closer contact with this important area and to further the cultivation of food crops on the South Coast as part of the "Grow More Food" campaign.

The venture was a complete success, thanks to the splendid reception which we received at the hands of the growers, who spared no pains in discussing their problems with us and in giving all the information required.

Nowhere did we meet the slightest discouragement, and our special thanks are due to Mr. Young, a member of the Station Committee, Mr. V. H. Brautigam, Secretary of the Worthing Growers' Association, and Mr. Costin, Horticultural Superintendent for West Sussex.

At the request of the County War Agricultural Committee we undertook the survey of glasshouse properties in that area and visited some three hundred nurseries in West Sussex alone, many of them several times. Visits were also made in East Sussex and Surrey, where we enjoyed the loyal support of Mr. Johnson and Mr. Quarrell, the Horticultural Superintendents of East Sussex and Surrey respectively.

The period spent in Worthing provided the Station with first-hand information of the problems faced by growers on the Sussex soils. Thanks to the generosity of growers, who placed houses at our disposal for experimental purposes, it was possible to test our methods in that important glasshouse area, and so prove to the growers that the results obtained at Cheshunt were applicable to the Worthing area.

When the time came to return to Cheshunt, on 15th August, 1940, we all regretted the change, for it meant leaving a healthy district in which we had all thrived for many months. It also meant leaving a district where the high light intensity gave greater scope for crop research to return to the dull, humid area of the Lea Valley, where for many years our investigations had been hindered by conditions of poor light. We felt, however, that we had made a great many new friends and that our contacts in Worthing had established a degree of co-operation between the Worthing growers and the Research Station which it would have been impossible to obtain in any other way.

To maintain this co-operation Mr. W. H. Young has agreed to act as liaison officer between the Worthing growers and the Station, and Messrs. Williams and Richards will spend some time in the Worthing area every year at least for the duration of the war.

Other members of the Staff have concentrated upon isolated parts of the country since the Director returned from Worthing. Dr. Owen has visited most of the growers in North Wales, in the Counties of Anglesey, Caernarvon, Denbigh and Flint. Mr. Speyer has done similar work in Northumberland, while Mr. Read undertook the glasshouse survey in Essex and Dr. Selman in the Isle of Ely. Mr. Orchard continued his work as advisory officer to the Station, concentrating mainly on the Lea Valley area.

Separate accounts of these visits are included in this report because they should prove helpful to the districts concerned.

It is clear that the average yield of tomatoes in this country could be greatly improved if the standard methods of cultivation recommended by this Station were practised more widely.

Many growers all over the country, especially those outside the large glasshouse areas, are ploughing a lonely furrow and do not seem to be acquainted with modern methods. Most of those visited knew of the existence of the Cheshunt Station, but many had made no contact with it and were very pleased to be visited by a member of the Staff.

Many new members have been obtained as a result of these visits.

Our plan for visiting growers during time of war should benefit the glasshouse industry by taking the results of research to every nursery, and it is hoped that our experiences will enable us to form a practical scheme which can be applied effectively when the war ends.

1. West Sussex.

W. F. Bewley, P. H. Williams, A. A. Richards.

Removal to Worthing at the end of November gave us an opportunity of seeing the chrysanthemum crop and discussing with growers details of soil treatment in preparation for the next season's work. Walking around nurseries, driving on wet nursery roads, and observation of the soil in process of digging revealed in no uncertain fashion the nature of the "sticky" Sussex land. The soil type was so different from that in the Lea Valley area that we expected to meet many new problems, nor were we disappointed.

The soil on the older nurseries breaks up well after thorough cultivation and gives a good tilth at planting time, but as the result of later watering and trampling, a close "skin" or "crust" forms on the surface, with all its accompanying difficulties.

The prevention of this tight surface layer is one of the big problems in Sussex. The second problem is associated with the physical state of the soil and the fact that the tomato crop follows closely upon the chrysanthemums and leaves no time for winter flooding. These two problems will be discussed later.

The Sussex area is noteworthy as being one of the oldest glasshouse districts in the country and examples of very old types of construction are still to be found there. The nurseries vary in size, from a few small houses on holdings where many kinds of plants are grown both under glass and

in the open, to the large modern nurseries with central heating, specialising in tomatoes, cucumbers, chrysanthemums and mushrooms. Other important crops are grapes, peaches, nectarines, lettuce, climbing and dwarf beans, forced strawberries, carnations and orchids.

Most of the glasshouses in West Sussex are found between Shoreham and Littlehampton, south of a tall range of chalk hills running parallel to and about two miles away from the coastline. These hills provide good shelter from the cold north winds. The nurseries in the Shoreham area are of the smaller type engaged in mixed crops, and catering principally for the Brighton and other local markets. At Worthing the industry is more concentrated and the produce is sent to London and the Provincial markets. During the last ten years many nurseries have been started in the Angmering and Rustington areas. A large area is situated near Chichester but the nurseries are scattered and extend down to Bognor and Thorney Island. Further inland are groups of nurseries around Thakeham and Horsham, many of which specialise almost entirely in carnations.

In a district where the fullest advantage is taken of keeping the houses filled with crops during the whole year, and where it is difficult to rest the soil during the winter months, certain difficulties are bound to occur, chief of which is the rapid falling off in fertility which must be counteracted by sterilization each year. The application of chemical sterilizers and the more laborious method of occasionally removing the old soil and replacing it with new soil are the treatments most commonly adopted. For tomato growers the difficulty, and often the impossibility, of winter flooding is a serious drawback.

The importance of winter flooding cannot be overemphasized, and successful tomato culture is handicapped to an enormous extent if the subsoil is dry at the commencement of the season, because almost without exception the plants react either by refusing to set the lower trusses or by producing small irregular fruit.

We found many growers who practise overhead damping as a routine process and it was gratifying to observe the perfect setting of the trusses.

Lettuce cultivation should prove a valuable asset to the Sussex growers, for the stronger light and the absence of serious fogs contribute greatly to its success. Many excellent

crops were inspected, especially of Cheshunt Early Giant. It is interesting to note how great a favourite Cheshunt Early Ball has become with the East Sussex growers where it is grown in cold houses throughout the winter.

Climbing French beans are treated as an important main crop from February to July; Guernsey Runner and Tender and True being the two principal varieties. The cultivation of crops grown commercially in this area follows a uniform plan, but beans are an exception, and it was interesting to note how varied was the distance of planting, preparation of the borders, feeding and treatment of laterals.

Grape growing was at one time carried out on a very large scale throughout the district, but with the coming of larger supplies from overseas, and the consequent lowering of prices, the production of this crop diminished until to-day it is carried on only by growers who produce fruit of the highest quality.

Peaches and nectarines, also, are not nearly so extensively grown to-day as formerly, but it is evident from the careful treatment of the trees throughout their growth, and the fact that the production of fruit 12 to 14 ounces in weight is the grower's aim, that those growers who still continue peach culture are "specialists" in the work.

Forced strawberries are in the hands of a limited number of growers who spend much time and trouble in producing very early fruit of excellent quality, colour, and flavour. High light intensity and an early season must surely be a valuable asset in the production of these early fruits.

One of the most important crops of the Worthing area is the mushroom. Indeed in peace time practically every grower, large and small, devotes some part of his nursery to a winter crop of mushrooms. Excellent crops are invariably the rule and great care is taken over composting the manure and in preparing soil for casing the beds.

Many original and quite unorthodox methods were encountered. These include novel methods for supporting the beds, and more prolonged fermentation of the manure before use. The fact that excellent crops were produced by such methods shows very clearly how little is known of mushroom work and provides new ideas for investigation.

Carnations are grown principally on the larger nurseries in high roomy houses, and we were impressed by the sturdy stems and intense colouring of the flowers, under suitable

soil conditions. Growers of carnations in Sussex favour the raised bed system, bricks, clinkers, and small land drains being used for this purpose.

Perhaps the most widely-grown crop of all in the South Coast area is the chrysanthemum. Almost every grower devotes a large part of his outside ground to this crop both for early outdoor cut flowers and for lifting purposes. These growers maintain that by careful planning and cropping of their houses with mushrooms, beans, tomatoes, lettuce, and chrysanthemums they are able to keep their workmen fully employed throughout the year, and it is their proud boast that they have "something coming in" each week.

Worthing has always been noted for its figs, and some authorities go so far as to say that its cultivation was introduced there by Thomas à Beckett. That may or may not be true, but to-day there is only one nursery specialising in figs under glass, although everywhere outside venerable specimens can be seen growing against an ancient wall. There was a time, however, when Worthing was noted as much for its figs as for any other crop.

One of the most important tomato diseases in West Sussex is the "Wilt" which occurs in the summer. This disease is not confined to Sussex but occurs in other parts of the country, and appears to be becoming more common. From the nature of our laboratory arrangements it was not possible to carry out extensive experiments, but many useful observations have been made and will form the basis of future work. Through the courtesy of Mr. Darke, of Durrington Orchards, it was possible to examine roots of affected plants at intervals from the beginning of March to the beginning of May. There appears to be some evidence of a succession of fungi in the roots, species of *Ramularia* being most abundant in early March and becoming rarer as the season advanced. A grey sterile fungus was found constantly in mid-March and continued to occur frequently during April. *Acremonium* sp., which may be regarded as a saprophyte, increased in frequency during April. The exact role played by these fungi and other organisms, including various types of bacteria, remains to be determined. It is evident that we are dealing with a complex problem in which physical conditions in the soil play their part. In this connection, the use of straw in vertical walls has proved of value. In a house which Mr. Darke placed at our disposal, the difference in growth and health between plants in soil where straw had been used and in plots without straw was very striking.

Wilt due to *Verticillium albo-atrum* was widespread but not in most cases severe. Another soil-borne trouble which appeared frequently was Root Knot caused by the eelworm, *Heterodera marioni*. It was interesting to find that a number of growers had good results from treating the soil with potassium iodide, a treatment suggested by the Station several years ago. In this treatment 2 ounces of potassium iodide are dissolved in 30 gallons of water and applied to 100 square yards. The solution should be applied two to three weeks before planting, again at planting time, and twice later in the season. The way in which this substance acts in preventing root attack is not understood, but it is possible that the type of soil may have some influence.

"Damping off" and Foot Rot of tomatoes due to species of *Phytophthora* were frequently noticed both in the early part of the year and later when plants destined to follow the bean crop were being propagated. In some cases it was evident that Foot Rot in the borders was due to infection in the propagating house, and it is to be regretted that a few growers appeared to take no steps to minimise this infection by removing and destroying affected plants on the bench as soon as they were seen.

Virus diseases were widespread throughout the area. A symptom observed several times during the early part of the season was flagging of the top of the plant. This may be mistaken for wilting due to other causes, but the peculiar "fuzzy" growth of the plant top is unmistakable. Later, mottling of the fruit due either to Streak or Mosaic was fairly common. In several cases plants suffering from virus diseases were noticed in propagating houses. Roguing out these plants is most important, since they serve as a source of infection for the whole crop, and as Dr. Selman shews later in this Report early infection with virus disease leads to severe loss in crop.

The most important pest of tomatoes in glasshouses in the Sussex area proved to be Wireworms. It seems likely that the practice of lifting chrysanthemums is responsible for their prevalence since they must be brought in each year in the ball of soil around the roots. Trapping with broccoli stems is carried out extensively, but cannot be expected to provide a satisfactory control under these conditions.

Verticillium wilt of the chrysanthemum appears to be widespread in the area. To control this disease careful selection of the stock for cuttings is necessary, and it may be suggested that growers would find it profitable to mark well-

grown and healthy plants at or before flowering time and take cuttings only from these. The buoyant atmosphere makes it possible for growers in Sussex to plant their chrysanthemums very closely, but in a few cases growers had been tempted to overstep the limit and severe blighting of blooms by *Botrytis cinerea* was the result. Attacks of rust, *Puccinia chrysanthemi*, are likewise favoured by these conditions, and several cases of this disease were noted.

Mushrooms were relatively free from disease, as may be expected in a district where their cultivation is a speciality. One severe attack of *Dactylium dendroides* was noted on an old bed in an unheated shed and a few cases of *Mycogone* and *Fusarium* were also seen. The peculiar condition known as "flock," in which the gills are suppressed and the fruit body becomes hard and fleshy, also gave trouble to some growers.

A few cases of *Verticillium* wilt of the cucumber were observed, but apart from this the crop appeared healthy except for attacks of powdery mildew.

A bean disease causing trouble on some nurseries was a foot rot caused by a species of *Pythium*. Plants in the borders suddenly flagged and died. The disease was controlled by replanting and watering in the new plants with Cheshunt Compound. A few cases of Mosaic were noted, but on the whole bean crops appeared free from this disease.

2. Lea Valley.

O. B. Orchard.

In accordance with the wartime policy of the Research Station the past season has been fully occupied in assisting growers to obtain maximum crops. It is a pleasure to record that they have been ready to co-operate where advice was requested. Owing to wartime conditions there has been a change over from general crops to tomatoes, and on many nurseries tomatoes were grown for the first time following cucumbers, roses, and other flower crops.

Many growers had little or no experience of tomato cultivation on a commercial scale, and they deserve full praise for the quality and the weight of crops produced.

As was expected, in some instances, early growth was very strong and unbalanced, but by the growers' ready adoption of methods advised few if any failures were experienced in setting the lower trusses.

Throughout the district tomato crops were moderately heavy during the early season. Mainly owing to the hot summer crops on many nurseries suffered severely by reason of a dry sub-soil. On many soils it appeared quite impossible to get the sub-soil sufficiently moist during May and early June in spite of almost daily watering, and in consequence the sixth and seventh trusses were in many instances a complete failure, owing to "knuckling off" of the bloom.

Growers would be well advised to consider the use of straw placed in trenches as described in Circular No. 14, especially under conditions where panning of the surface soil makes it impossible for water to soak deeply into the soil.

In spite of the early promise, the majority of crops yielded very light "top crops." On many nurseries this may be attributed to insufficient water in the early summer, especially where bottom trusses were heavy, but in a number of cases Red Spider Mite and Tomato Leaf Mould were the main factors responsible for the loss of foliage and consequent collapse of plants.

Both of these troubles were more prevalent in this district than for many years, and although the hot season was very favourable to both, it is doubtful if growers tackled these problems as efficiently as they usually do. While it is admitted that many problems were involved, viewed from the National point of view, the loss of fruit from the "tops" was more serious than many growers appeared to appreciate.

Growers who may not be fully conversant with the most up-to-date methods of controlling any pest or disease of glasshouse crops are asked to communicate with the Director, who is particularly anxious to assist in maintaining maximum crop production.

The fungus, *Verticillium albo-atrum* (Sleepy Disease), was responsible for considerable loss of crops during the past season, and in view of the hot summer the severity of attack was remarkable. It must be emphasized that as soon as this disease occurs on the nursery steps should be taken the following winter to ensure its eradication. Thorough soil sterilization by steaming is the most satisfactory method of dealing with this disease, but to be completely effective the operation must be carried out thoroughly on the lines recommended by the Research Station. The method of quick steaming which is becoming increasingly popular will not destroy the fungus in the soil, and it is possible that the adoption of this method of steam sterilizing may be partly responsible for the increase in the number of nurseries showing loss of crop through this disease.

Where this fungus is known to be present, the grid system of steaming is more effective than the harrow or tray system, and it is essential to maintain a temperature of 212°F. for fifteen to twenty minutes after the temperature has been reached.

When it is impossible to sterilise by steam, chemical sterilization with formaldehyde is suggested. The control of the fungus is not so effective, and the results are not so lasting as obtained by steaming, and in most cases it is necessary to repeat the operation each winter. To control the fungus *Verticillium*, formaldehyde should be diluted one gallon to forty-nine gallons water, and this quantity should be applied over every 10 square yards. If applied over a greater area control of the fungus is often negligible.

Many excellent crops of lettuce and carrots were produced in the spring of the past season, and lettuce in glasshouses were particularly good. It is gratifying to find growers paying greater attention to the cultivation of this crop. From the quality obtained, there is every evidence that local growers are able to produce first grade lettuce as long as it is grown as a main crop and not as a catch crop left to grow as it will. In this connection growers are reminded that to obtain good quality produce and the minimum of loss it is essential to obtain a level and fairly fine tilth before planting in the houses. In the past, many crops of lettuce have been planted on rough and uneven ground and under such conditions the fungus *Botrytis* sp. breeds and spreads rapidly, and the consequent loss of crop has often been discouraging.

Although excellent crops were produced by many growers in cold frames normally employed for the cultivation of flowers and bedding plants, it is obvious that other growers have not realised fully the importance of such work. Valuable crops may be produced in all frames and on many vacant pieces of land where outside flowers are normally grown, and advice on the most suitable crop for the particular site will be freely given on application to the Director.

3. Essex.

W. H. Read.

At the request of the Essex War Agricultural Executive Committee a comprehensive survey of glasshouse holdings has been undertaken.

During the course of this survey much interesting information was obtained. As the survey was not commenced until September it is only possible to give an account of conditions existing at the end of the season.

The Epping district is the most important one in Essex, since it includes that portion of the Lea Valley which lies to the east of the River Lea, the Rochford district in the south-eastern corner of the county being next in importance. Glasshouse holdings are distributed over the whole of the county, but apart from the areas already mentioned, the greatest number are in the districts of Tendring, Billericay, and Chelmsford.

Since the outbreak of hostilities tomatoes have almost entirely replaced flower crops. Furthermore the area of cucumbers has been reduced and tomatoes grown instead. Many of the houses which were used for the production of flowers, pot plants, and bedding plants are old and of the low type.

On the older nurseries outside the Lea Valley there are many unheated houses and a large proportion of the heated houses are heated inadequately for early tomato and cucumber work.

Crops.

Tomatoes have always been the most important crop grown in glasshouses in Essex. The variety Potentate is probably the most popular one, especially in the Lea Valley, and Ailsa Craig probably ranks second. Very many other varieties are grown but it is impossible to list them in order of popularity. Good crops of Market King, Stonor's Exhibition, Kondine Red, Carrick, Gradewell, Hundredfold, Plumpton King, Moneymaker, Blaby, Mayland Beauty, and Prolific have been seen on nurseries in various parts of the county.

In several districts many of the growers with small glasshouse holdings sold their produce direct to consumers and preferred varieties yielding large trusses of fruit averaging twelve to the pound which were more easily saleable early in the season when prices were high.

A late crop of tomatoes followed early cucumbers on many nurseries and on several tomatoes grown in pots were taken into the houses after the main crop. Potentate appeared to be the most popular variety for this purpose.

Cucumbers are second in importance and they are mainly produced in the Epping and Rochford districts : few growers elsewhere cultivate this crop. In compliance with the request of the authorites there was a large decrease this year as compared with last year in the area devoted to the crop. Various strains of Butcher's Disease Resister are the chief varieties but Rochford's Improved Telegraph is also grown.

Lettuce.—Many growers are cultivating lettuces during the winter, chiefly the occupiers of small glasshouse holdings and older nurseries where heating arrangements do not permit of early tomato crops. On newer nurseries where tomatoes are planted out about the end of February crops of lettuce are not popular owing to the need for thorough preparation of the soil for tomatoes and cucumbers. The most popular varieties for forcing are Cheshunt Early Giant, Gottè a forcèr, Blackpool, Green Frame, and Golden Ball.

Growers have stated that good crops of Cheshunt Early Giant were grown in cold houses in spite of the severity of the last winter but these were cut very late. Others have grown successfully All the Year Round, May King, and Cheshunt Early Ball.

A wide range of food crops are grown in glasshouses in Essex, including beans, radishes, cauliflowers, carrots, and mustard and cress. Beans are the most important of these and are grown by a few growers in most districts. Grapes and peaches are also grown, the former on a large scale by one nurseryman only. Nurserymen who specialized in melon culture before the war are now growing tomatoes.

Flower Crops.

Before the war Essex was important for its flowers grown both outside and in glasshouses. Chrysanthemums are still grown on a considerable scale and while a number of good crops have been seen there were many inferior ones. This applies particularly to lifted chrysanthemums. Many nurseries in the Rochford district were almost entirely devoted to flower production before the war and many of the smaller nurseries produced bedding plants for sale in large quantities as well as flowers for sale as cut blooms. Vegetable plants for sale have replaced bedding plants to a large extent. Perennial flowering plants have been interplanted with food crops on several nurseries and although in many cases this has been detrimental to the flower crops excellent yields of salads, carrots, and tomatoes have been obtained. Many who normally grow outdoor flowers have replaced them by outdoor tomatoes and, judging from the successful crops obtained, parts of the county appear eminently suitable for this crop. The problems of growers of glasshouse crops appear to be mainly cultural, especially in the more scattered districts where many of the pests prevalent in the

Lea Valley are rare. Red Spider mite is unknown on many nurseries but appears to be spreading in the Rochford and Tendring districts. In two cases it is stated to have been introduced on tomato plants purchased ready for planting and the danger of contaminating a clean nursery in this manner is obvious.

The tomato moth caterpillar is also unknown in most districts. White-fly is a serious pest in many places but most growers find calcium cyanide gives an excellent control.

Tomato Leaf Mould (mildew) occurs in all districts but no serious attacks were seen. *Verticillium* wilt is common in all districts and several severe cases causing crops to be completely ruined were seen. The majority of nurserymen are unable to hire steaming equipment and in consequence must rely on formaldehyde or tar acid preparations. Many of the occupiers of small nurseries grow a succession of crops throughout the year and in consequence are unable to sterilize their soil. It is on these nurseries that the growth of the plants almost invariably suggests the need for soil sterilization.

A serious attack of tomato eelworm was noticed on one nursery but chrysanthemum eelworm was seen on a very large number of nurseries.

Botrytis rot of lettuce is also prevalent on many nurseries. In some instances this was probably aggravated by the old, leaky nature of the houses, in others through failing to get the necessary tilth on the soil, and in others through bad cultural conditions such as overcrowding in seed boxes or the seed bed, neglect to remove rubbish from the houses, etc. It is somewhat surprising to find so many nurseries taking their water supply from ponds or streams. The use of unsterilized soil for propagating is usual in most districts other than Epping and Tendring, except by younger growers and people with Lea Valley experience.

The cultural problems are much the same in all districts and no district can be said to have a special problem of its own.

4. Isle of Ely.

I. W. Selman.

The glasshouse industry in this county is largely confined to the Wisbech, March, and Whittlesey districts. The nurseries, though not large by Lea Valley standards, are usually supplemented by the intensive cultivation of vegetables, flowers, and bulbs outdoors. The majority are mixed nurseries devoting the early spring months to the raising of cauliflower, onion, or celery seedlings for farmers or market gardeners. The forcing of bulbs or the production of bedding plants for local sale are also widely carried

out. Celery raising has developed into quite a specialized local industry at Whittlesey and millions of celery seedlings are supplied to farmers annually. Tomatoes are grown in the houses during the summer and many potato-chitting houses on the farms are utilized for a late tomato crop.

With the increased demand for food crops, many growers are changing over from the production of carnations, bulbs, or bedding plants to tomato growing. Much interest was expressed by the growers in the services provided by this Station, particularly in view of the special problems which are now being encountered by the continuous cropping of the houses with tomatoes.

On the soils of many old-established nurseries in the district, there has been a tremendous decline in productivity in the past few years, which appears to be due largely to the depredations of fungal and insect pests in the soil, notably *Verticillium*, *Phytophthora*, and eelworm. The plants frequently fail to set more than four trusses despite adequate manuring. Annual re-soiling is practised in a few nurseries as a means of combating this loss, and as a result wireworms were found to do serious damage in many cases. A great need for the extension of soil sterilization was manifest, either through suitable instruction in chemical methods or by some co-operative scheme for steam sterilization. A recommendation to this effect was made to the Horticultural Sub-Committee of the Isle.

Among the most popular varieties of tomato grown in this area are " Market King " and several of the Stonor's varieties, but the value of the improved strains of " Potentate " for early cropping and forcing does not appear to be generally recognized here.

Salt pollution was found to be serious in parts of the Wisbech area, where wells had been sunk much below 12 or 15 feet. Fortunately the district is now widely served by the Marham water supply.

Tomato " mosaic " was widespread but " stripe " was not severe this season. It is interesting to record that no case of the virulent mixed potato-tomato streak virus disease was observed on any of the nurseries inspected although this is also an important potato growing district. The potential danger of introducing potato virus diseases into the tomato crop through the use of potato tubers as wireworm bait has been pointed out.

Inadequate potash manuring was noted in some crops, evident by the poorly developed truss stalks and the large proportion of blotchy fruit. The difficulties of obtaining sulphate of potash together with the low reserves in the soil, will shortly become a serious handicap on a few of the poorer nurseries.

This survey has indicated clearly the desirability of bringing recent developments in pest and disease control and cultural methods for glasshouse food crops, more directly to the notice of the smaller growers, if their output of glasshouse produce is to be increased or even maintained, during war-time.

5. North Wales.

O. Owen.

In North Wales visits were made to forty-eight nurseries in the Counties of Anglesey, Caernarvon, Denbigh, and Flint. In all the counties the horticultural organizers were most helpful and were it not for their sympathetic co-operation it would have been impossible to have made contact with so many growers in the time available.

Generally speaking, growers who were not already using the services of the Station were very glad to know of the facilities offered and it is expected that, in future, they will make use of the Station.

With two exceptions the nurseries were of the " mixed " type ; that is to say, glasshouse work was only one item—and often not the most important one —in the business. Most of the produce is sold to local retailers and in some cases the growers sell direct to the public either on the nurseries themselves or in their own shops. In peace-time cut flowers were an important crop and in many cases the wreath-trade was also of importance. On two nurseries very good crops of outdoor tomatoes were seen.

Under glass the crops were tomatoes, lettuce, and chrysanthemums, although a few vines were seen. The most popular varieties of lettuce for winter forcing were Cheshunt Early Giant and Blackpool and it is worth noting that Early Giant has been grown cold in several districts. This winter many growers are trying Cheshunt Early Ball in frames. Most popular tomato varieties are E.S. 1, Ailsa Craig, Plumpton King, and Victory. Very few growers liked Potentate.

It appears that tomato leaf mould is prevalent generally although quite a number of growers are using proprietary sprays against it. White fly infestation was not serious anywhere. On most nurseries the white fly parasite was known and had been used in quite a number of places. On several nurseries cyaniding is practised. Only on one tomato nursery did there seem to be any red spider mite.

Owing to the lateness of the season it was not often possible to judge the condition of the plants but in many cases it was clear that very little fruit had been obtained from the " middle " of the

plants, i.e. from the fifth, sixth, and seventh trusses. From this evidence and conversation with the owners it was gathered that dry subsoil conditions had prevailed. In addition there were many indications of a deficiency of nitrogen in the latter part of the season. In this connection it is worthy of mention that feeding of tomato plants is not so systematic as it is in the larger nurseries in the South of England, and one is forced to the conclusion that better crops might result from regular feeding.

With regard to soil treatment the indications were that re-soiling is not practised so much as formerly and this calls for the reminder that where re-soiling is carried out on account of the incidence of disease it is essential that the base remaining in the house should be sterilized before new soil is brought in. A few growers use steam for sterilizing but the majority use formaldehyde or one or other of the proprietary emulsified tar acids of the cresylic type.

It is worth while recording that on two nurseries where leaf mould was general, some of the Station's mildew resistant varieties were clean.

6. Northumberland.

E. R. Speyer.

The main object in visiting some thirty nurseries in Northumberland was to make contact with the growers, many of whom live in outlying districts. Few of the nurserymen were aware of the real function of the Cheshunt Station, and most knew of its existence only from the lettuce and the fungicide which bear its name.

Between Newcastle and Morpeth there exists a large colony of glasshouse growers, the majority owning from three to five glasshouses, but larger nurseries ranging from one to three acres in area exist near Newcastle. Small nurseries are also situated in the vicinity of the smaller towns as far north as Berwick.

Although a number of nurseries are of long standing—up to forty years—the majority of glasshouses have been cropped only for some six or seven years. The soil is mostly a heavy, and sometimes sticky boulder clay, but deep dark-coloured medium loam also occurs, sometimes in such close proximity with the clay, that one portion of a single nursery may be upon clay and the other upon loam.

Crops are grown in quick succession, chrysanthemums following tomatoes, and lettuce preceding the latter. Varieties of tomato chiefly grown are Ailsa Craig, Kondine Red, Market King, those raised by Mr. Stonor, and local varieties. Only upon isolated

nurseries were Potentate and E.S. 1 being tested, the latter with marked success upon heavy clay soil. In the majority of cases fine fruit was seen on the tops of the plants up to the end of October. The weight of crop, however, taken over the season was generally low, largely due to poverty of the soil after many years' cropping. Although formaldehyde sterilization is very generally practised, means for steam-sterilization are not available, except upon one or two nurseries. Further, stable manure is difficult to obtain, and the soil of many nurseries is becoming rapidly exhausted. Attempts have been made to bring new soil from surrounding land into the houses, but this is often so severely infested with wireworms that constant replacement of plants at the beginning of the season is necessary.

Of the diseases and pests of the tomato, *Cladosporium* is prevalent but not necessarily of great severity ; the symptoms of virus diseases are much in evidence upon plants growing in poor and unbalanced soils, Spotted Wilt in particular, though much less severe during the past season, being prevalent upon nurseries where mixed plants have grown during the preceding five years. There appears, however, to be a tendency for growers to avoid the practice of growing mixed crops, the change having beneficial effects on the tomato crop. Red spider mite appears to be absent—certainly upon tomato plants : white-fly is prevalent only upon nurseries where mixed plants are grown ; its parasite, *Encarsia*, was found upon several nurseries and the percentage of parasitism was very high ; on others, however, it was entirely absent. The chief pest of the county is undoubtedly wireworm, and its control is a matter of great difficulty in the absence of apparatus for steaming the soil.

Lettuce is grown largely, both in glasshouses and in cold frames : for the former Cheshunt Early Giant is greatly in favour ; growers in general take particular care over this crop and succeed in producing excellent heads.

Chrysanthemum plants were particularly free from disease ; only in single cases were capsids, a black Aphis, and *Verticillium* observed, mildew being present occasionally.

3. Plant Diseases.

1. Some interesting Plant Diseases.

P. H. Williams.

During June specimens of wilted tomato plants were received at Worthing from Guernsey. These had been numbered 1–8 by the grower who suspected the presence of both *Verticillium albo-atrum* and *Fusarium bulbigenum* var. *lycopersici*. On examination it was found that five of the plants showed a dark browning of the wood and from four of these *Fusarium bulbigenum* var. *lycopersici* was isolated, the remaining one giving *Verticillium*. The wood of the other three plants was light brown in colour and from them *Verticillium* was isolated. The results tend to shew that the degree of browning in the stem is of assistance in preliminary diagnosis in cases of tomato wilt. The presence of the two fungi on the same nursery is interesting. A similar state of affairs has been reported from California where *Fusarium* wilt appears during the hot part of the summer and *Verticillium* during the cooler part.

During February tulips were examined which shewed distortion of the outer leaves with necrotic areas on them. The inner leaves were slightly mottled. No fungus or other parasite was found and it was concluded that the damage was due to frost. Similar damage attributed to the same cause was reported from Lincolnshire early this year.

Several cases of Foot rot of Climbing French beans were seen in the early summer. The tissues at the base of the stem were rotted and the plant collapsed and died. The organism present appeared to be a species of *Pythium* but under the circumstances it was impossible to carry out detailed cultural studies. The disease was controlled by removing infected plants and watering in replacements with Cheshunt Compound.

Two diseases of Gardenia were noted. In one case the stem was girdled and the plant died. *Botrytis cinerea* was isolated from the affected tissue. In the other case the disease was due to *Phomopsis gardeniæ*, cankers being formed at the base of the stem.

An interesting form of attack by *Botrytis cinerea* on Cos lettuce, variety Lobjoit's Improved, was noted during June. The fungus usually started at the edges of one of the heart leaves and from thence spread into the heart, completely rotting it. Both tied and untied hearts were attacked. The plants were growing on a well-drained south slope. It may be suggested that the disease was in part due to excessively dry soil which led to water shortage in the plant. This combined with exposure to the sun resulted in the collapse of some of the tissues which were invaded by the *Botrytis*.

2. Root-Rot of French Beans

H. L. White.

The results of investigations relating to the Root-Rot diseases of French beans may be summarized as follows :—

Symptoms.

The disease is characterized on nurseries by a reddish canker at the base of the stem associated with stunting, yellowing of the leaves, and wilt.

Isolation.

Owing to the nature of the disease, primarily a cortical root rot, the use of standardized technique leads to the isolation from diseased tissues of a large number of different organisms, many presumably being associated only with secondary stages of the disease. By the use of a highly buffered acid medium two types of *Fusaria* have been isolated from diseased plants sufficiently consistently to justify the view that either or both are implicated in the primary stages of the disease. Type A is a relatively slow-growing fungus with sparse aerial mycelium and extensive blue pionnotes (on media with high sugar content) while, under similar conditions, Type B is a relatively rapid-growing fungus with extensive aerial mycelium and yellow-green sporodochia. Nevertheless some batches of plants have yielded neither of these types but a fungus forming a continuous pinkish layer of one-celled conidia, while in the isolates from other batches a sterile white mycelium predominates. Since the latter types were obtained rarely and not associated in general with the disease they were not cleaned from bacterial contaminations but were discarded together with obvious secondary organisms.

Inoculation.

Inoculations with spores of different strains of the fungus referred to above as Type A have been consistently associated with the production of a reddish canker at the base of the stem, whereas the results of inoculations with a large number of other isolates, mainly *Fusaria* have been uniformly negative. Inoculation with the mycelium of a type culture of *Fusarium solani* var. *Martii f 3*, the recognized causal organism of Dry Root Rot of the bean, has been followed by the production of apparently similar cankers at the base of the stem.

Causal Organism.

Direct comparison between the spore dimensions, etc., of the fungus referred to above as Type A and the type culture of *F. solani Martii f 3.* has not as yet been possible since the latter consists of a sterile mycelium. In the hope of changing this condition a comparative study has been made on a wide variety of media but in only one instance has the sterile form been induced to form

macroconidia and these were clearly abnormal in character and subnormal in size. Methods to induce sporing recommended in the literature, such as transference through the host and continuous sub-culturing from macroconidia, have been carried out with consistently unsuccessful results. On the other hand the reverse change from sporing to mycelial form is readily attained, the latter forms all proving pathogenic in the cases so far tested. On re-isolating from three plants inoculated with the sterile form, two sterile cultures apparently free from other organisms, were obtained while the third culture, which was contaminated with bacteria, formed a pinkish pionnotal layer of microconidia. This suggests in view of similar isolates from naturally diseased plants, that the pathogen occurs on nurseries, as well as in culture, in forms so morphologically dissimilar as to give rise to the view that different fungi are being studied.

It is of interest to note that highly significant differences have been recorded in culture between the fungus referred to above as Type A and the pathogen of Dry Root Rot of Pea, *Fusarium solani* var. *Martii f 2*, although the latter fungus is reputed to be morphologically identical with *Fusarium solani* var. *Martii f 3*.

Incidence of Disease.

Six comprehensive inoculation experiments have been carried out and in each case 100 per cent infection, denoted by the appearance of the red cankers at the stem base, has been obtained. In a limited number of cases inoculation of germinating seedlings has been followed by death of the plant but in all other cases the lesions have remained superficial and little interference with the growth or cropping of the plant has been detected. This suggests that, *Fusarium* may be solely responsible for primary infection, but that other organisms subsequently invading the tissues may be mainly responsible for symptoms of stunting and wilt. Support is given to this supposition by the results of stem inoculations with *Fusarium* alone and in conjunction with bacterial contaminants for in the latter case a significant increase in the rate of extension of the lesions was recorded.

Control.

The slow rate of spread of the lesions, the resistance of mature vascular tissues and the local nature of root lesions following planting in heavily contaminated soil lead to the view that a practicable method of control could be attained if the plant could be kept free from contact with the disease in the seedling stages. This end is achieved by sowing in sterilized soil or peat and then planting out into the houses with the stem protected by the rim of a bottomless pot. On the basis of the appearance of the red cankers at soil level very promising results have been obtained but these cannot be considered decisive until it is possible to reproduce the full effects of stunting and wilt in the control plants.

3. Virus Diseases.

The effect of Tomato "Mosaic" on the Tomato Crop.

I. W. Selman.

A replicated experiment has been carried out to investigate the effect of three common "mosaic" diseases on the fruiting of a crop of "Potentate" tomato plants, grown to five trusses in a cucumber house, as nearly as possible under the conditions of nursery practice. The control plants were all kept healthy until the fifth truss was in bloom, when accidental infection occurred. The diseased plants were artificially infected when the first truss was coming into bloom, with: (*a*) a severe-mottle streak virus, which tended to induce stem streaks; (*b*) a mild-mottle streak virus, which but rarely induced streaks [1]; and (*c*) mild tobacco mosaic (*TbV1* J. Johnson) which normally induces only a faint, greenish leaf mottle in tomato.

A summary of the results obtained is presented below: a detailed account will be published later.

Production of Flower Buds and Setting of Fruit.

The number of flower buds produced in five trusses and the fraction of those flowers which set fruit were all reduced by the presence of virus disease. The magnitude of the losses is indicated in Table 1, but it has been shewn from a statistical examination of the data, that in this experiment the reduction in the number of flowers setting fruit was the more important effect.

Table 1.

Treatment	No. of Flower buds per plant	Relative loss in flower buds	No. of fruits/ plant	Flowers setting fruit	Relative loss in fruit set
		%		%	%
Control	36·2	—	30·4	83·9	—
Severe mottle streak ...	33·1	8·6	24·0	72·5	13·6
Mild mottle streak ...	32·8	9·4	25·4	77·4	7·7
Mild tobacco mosaic	32·2	11·1	25·3	78·6	6·3

[1] A note on the symptoms induced by this virus (A 15) appears on p. 37, *Ann. Rep.*, xxv, 1939.

It appears that two distinct processes may be affected by the viruses ; firstly the differentiation of flower buds, and secondly the setting of fruit. Nitrogen manuring, air temperature, soil moisture and atmospheric humidity are probably the most important single factors affecting these processes and which are also under the control of the grower. In practice it has been noted that a light dressing of a quick-acting nitrogenous manure together with a slight increase in atmospheric humidity, according to local conditions, does assist the plant to overcome these serious early effects of virus infection. Additional care in these respects are necessary as soon as the first mottling of the tops is apparent.

With severe mottle streak the plants tended to wilt badly during the week following the appearance of symptoms, particularly in the forenoon when the vents were opened. This symptom has also been noted in plants growing in the silt soils of the Worthing area when virus has been present. Careful control of ventilation and damping was a simple remedy.

A heavy loss of fruit is often attributable to the processes mentioned above, a fact which is frequently overlooked in view of the more spectacular " blotchy fruit " effects of virus diseases.

Blotchy Fruit.

In this category was included all pitted fruit and fruit in which pigment development was so irregular as to affect market value. It was interesting to find that although the presence of virus increased the percentage of blotchy fruit in all cases, in addition the position of the truss on the plant and the location of the plant in the house all affected significantly the amount of blotchy fruit produced. The incidence or severity of blotchiness alone must not therefore be taken as a measure of the severity of virus attack.

In the severe mottle streak group 6·6 per cent by weight of the fruit was blotchy as compared with 3·4 per cent in the Control group. The relatively small amounts of blotchy fruit produced may be a reflection of the high fertility of the old cucumber soil.

Types of Fruit Markings.

Almost every fruit from a virus-infected plant exhibited very faint irregularities in the colour of the red skin pigment. This " mistiness " is usually disregarded by packers grading fruit for market but is very evident to the discerning buyer. The following more severe symptoms were noted :—

(1) Sunken Pits.

Pitted fruits have been attributed to the action of various pathogenic agents of which streak is probably the most widespread in this country. In this experiment it was found that the occurrence

of pitting was irregular and bore no simple relation either to the position of the plant in the house or to the presence of any one of the viruses mentioned above. The largest number of pitted fruits was found on a control plant which became infected relatively late in the season with a streak virus.

(2) Dull greenish-red fruits with granular pigmentation.

(3) Highly glazed surface of fruit, with granular pigmentation.

(4) Orange or yellow blotches.

(5) Longitudinal yellow streaks.

It may be noted here that plants infected with *Cucumber virus 1* (frequently included under " Tomato Mosaic ") produced some fruits with a distinctive green and red mosaic patterning. The coloured areas were sharply demarcated without colour gradation and no pits were present. Other plants containing this virus produced fruits with irregular, glazed, whitish-coloured areas. Neither of these fruit symptoms appeared on the streak or tobacco virus infected plants.

Leaf Symptoms.

The general description of mosaic on crop plants given by Bewley and Corbett [1] has been confirmed and amplified by a study of the symptoms displayed throughout the season by early-infected plants. A feature of these studies was the diversity of symptoms and the ever-changing picture presented by any one plant. Thus certain plants infected with a streak virus (either mild or severe mottle) shewed successively or in conjunction, the following symptoms *on one and the same plant.*

(1) Light-green, dark-green mottle of the leaves.

(2) Yellow-green mottle of the leaves.

(3) Light-brown stem streaks (one form of " Stripe ").

(4) Brownish necrotic spots on the young leaves.

(5) Distortion and puckering of the leaf lamina.

(6) Blistering of the lamina.

(7) " Enations " or small leafy outgrowths on the under sides of certain leaves.

(8) Dissected leaflets.

The few cases of stem streaks which appeared early in the season did not prove fatal, and with careful culture yielded fair crops. Day temperatures of 70° F. and over, led to some reduction in the severity of the leaf mottling.

[1] *Ann. Rep.*, xvi, 1930.

Total Yield and Grades of Fruit.

In Table 2 the crop yields in tons per acre of the various treatments are presented, together with the weights of the several market grades. With " Blues " have been included those fruits sometimes designated " Roughs ". The prices quoted are for mid-July, 1938 (Covent Garden). Wartime prices would tend to accentuate the differences recorded on page 48.

It is not suggested that the average nursery is likely to suffer 100 per cent virus infection at the time of planting out, nevertheless the results here reported confirm the value of keeping crop plants free from virus infection for as long a period as possible. The value of simple precautions against virus spread is illustrated in this experiment, for the control plants did not become infected until mid June although growing in plots adjacent to diseased plants from the end of March.

Every effort should be made to eliminate infected seedlings by the use of clean seed and the practice of the elementary hygienic measures advocated in earlier reports of this Station.

It is of interest to note that the suggestion made in the report for 1939 concerning the possible use of a strain of mild mottle streak (A 15) as a type of " Vaccine " is borne out by the results of this experiment. On a financial basis it would appear to be more desirable to " protect " plants by infecting them artificially with a mild virus than to permit the fortuitous entry of more virulent types, assuming that no effort for complete virus elimination were being made.

Table 2.

Grade	Price per 12 lb. box (July, 1938)	Severe mottle streak		Mild mosaic (Tobacco)		Mild mottle streak		Control	
		Tons/acre	£	Tons/acre	£	Tons/acre	£	Tons/acre	£
Pink	5/3	2·656	130·1	2·643	129·5	3·854	188·8	5·728	280·7
Pink and white ...	5/9	8·939	480·0	9·792	525·8	10·929	586·9	10·841	582·2
Pink and white × ...	5/6	4·494	230·5	5·635	289·1	4·573	234·6	5·886	302·0
White	5/–	0·971	45·3	0·837	39·1	0·628	29·3	0·982	45·9
Blue	4/3	3·008	119·4	1·715	68·1	2·043	81·1	2·403	95·4
Total		20·07	1,005·3	20·620	1,051·6	22·03	1,120·7	25·840	1,306·2
Cash Loss per acre on five trusses ...			£300·9		£254·6		£185·5		

Standard error of mean (Totals) = 0·786 tons/acre

4. Animal Pests.

1. Red Spider-Mite.

E. R. Speyer.

During recent years American scientists have carried out experiments with selenium compounds and have recorded that, not only do some of them kill the mite when applied to the foliage as sprays, but that others tend to immunize certain plants both from mite and aphid attack when incorporated with the soil in which they are grown.

Compounds of selenium are highly poisonous, and are known to occur in the foliage of edible plants growing in seleniferous soils in quantities which render the latter unfit for human or animal consumption. Under no circumstances can selenium compound be recommended as a means of pest control on any plant grown in glasshouses; even the case of flowering plants cannot be considered in this respect because edible crops such as tomato and lettuce might later be grown unwittingly in soils containing sufficient selenium to taint the fruit. Tomato fruit from plants grown in "selenized" soils is under process of test for the presence of selenium, but even if the result is negative, there is grave risk of some varieties being capable of storing the substance in their fruits.

The effect of feeding the mite on plants growing in selenized soil has been so striking, that an investigation was undertaken to determine the effect of selenium on Tomato Plants grown in such soils to determine the quantity of selenium, which it is possible to incorporate with the soil, without affecting the normal growth of the plant. The results of small-scale spraying experiments were also recorded to see if the mite is subject to contact action with selenium.

Throughout the experiments sodium selenate was employed and treatment of the soil was confined to pot-plants of the Tomato (varieties E.S.1. and Ailsa Craig) at Cheshunt during summer and autumn. It is not possible to give here any detailed account of the observations made.

1. Spraying.

Small quantities of sodium selenate dissolved in water containing 0·02% saponin as a wetting agent were applied to the foliage of infested tomato shoots, removed from the plants and kept with their stems in water for a period of two days. One per cent solution killed the active stages and the majority of resting stages of the mite: the foliage was severely scorched. In 0·2% and 0·1% solutions, only young mites in active stages were killed but the foliage was injured very considerably. In 0·005% solution, only a few young active stages were killed and the foliage slightly injured.

It appeared that the selenate had a distinct contact action upon the mites at the highest concentration, but death of mites at lower concentrations was probably due to stomach-poisoning from selenate absorbed by the plant tissues.

2. Shoots kept with their stalks in solutions.

Infested shoots were kept with their stalks in water containing sodium selenate at dilutions from 1% downwards to 0·005%. In all cases, except at the lowest concentration, the foliage withered within a period of two days. All mites except those in the egg and resting stages were killed upon shoots in a 1% solution—the majority, with variations, upon those in 0·2% down to 0·01% solutions, but only a few very young stages upon those in a 0·005% solution. It was concluded that the selenate had been conveyed through the tissues of the stem to the foliage, and that large numbers of mites, especially those in the larval and first nymphal stages had died within a short period after feeding upon the cell-contents of the leaves.

3. Application of sodium selenate solutions to the soil of pot plants.

The method of experiment adopted was the watering of the soil in which plants were growing with solutions at varying dilutions. In a few cases the pots were dipped in solutions to ensure complete saturation of the soil. One treatment only was given in each case. About a week after treatment tomato foliage upon which mites were breeding extensively was kept in contact with that of the experimental plants, or the latter were placed upon staging amongst severely infested plants. In each series of experiments, untreated plants subject to similar infestation by the mite were kept as controls: without exception these developed severe infestation in the course of two weeks. In some instances plants with mites already established upon them before treatment were kept under observation. When necessary, and sometimes soon after treatment, the plants were repotted with their "ball" of soil undisturbed and grown on in 9-inch or 12-inch pots.

Periodically, leaves of the experimental plants were examined and counts made of the number of living and dead mites in their different stages and of eggs deposited; these were compared with counts from corresponding leaves upon the control plants.

(*a*) *Plants treated in "60" size pots.*

(*i*) July 29th.—Soil of pots watered with 25 cc. of 0·1, 0·075, 0·05, 0·025, 0·01 and 0·005% solutions respectively; height of plants, 5½–6½ inches.

With the 0·075% solution the plant was severely injured and died later; with 0·1%, only one leaflet was injured, and the plant grew normally to maturity; all other plants were uninjured, and were similar to the control, producing a similar amount of fruit.

With 0·1% complete immunity from mite attack at least until November 18th was produced, very few eggs being found from time to time; with 0·05% many eggs were found but the young mites failed to develop and no serious infestation arose at any time. With concentrations below this, the plants became severely infested in August, and remained so until the end of November.

(*ii*) August 1st.—Plants treated by dipping the pots in 0·03, 0·015, 0·0075 and 0·00375% solutions respectively; height of plants 6 inches.

With 0·03% some initial injury was sustained, but the plant recovered. No infestation developed and hardly any eggs were deposited. With 0·015% no injury to the plant followed, and though a few eggs were deposited from time to time, no infestation developed. With the two weaker solutions the plants developed severe infestation which persisted into November.

(*iii*) August 23rd.—Pots of 5 plants were each watered with 100 cc. of a 0·015% solution; height of plants 6 inches. The plants, which grew and fruited as the control, sustained no injury. All except one remained practically immune from attack at least until the beginning of November. This single plant exhibited immunity until September 6th, though on that date more eggs were present upon the leaves than upon those of the other treated plants. From September 20th onwards, the infestation gradually increased until October 17th, when the plant had become as severely infested as the untreated control.

(*iv*) November 21st.—Owing to the tendency of the mites to go into hibernation late in the season, the pot-soil of this series was treated only with a view to testing the effect of sodium selenate on plants of various sizes at the time of treatment. Each pot was thoroughly watered once with the solution. Eleven concentrations ranging from 0·02% down to 0·006% were applied; for each dilution 2 plants from 10–12 inches high, and from 4–8 plants ranging from 1½ to 5½ inches in height were used.

During a period of from 4–14 days after treatment, all the plants between 10 and 12 inches high developed more or less severe leaf injury, except those treated with the lowest (0·006%) concentration. Amongst the whole series of smaller plants only two were injured, one being a plant 5½ inches high which received 0·016%, and the other a plant 4 inches high which was given the highest concentration (0·02%).

(*b*) *Plants treated in "32" size pots.*

(*i*) July 6th.—Soil of pots watered with 100 ccs. of 1·0, 0·5, and 0·1% solutions respectively; height of plants 14 inches.

With the two higher concentrations the plants were killed; with 0·1% the plant shewed no injury; during 5 months growth the plant grew and fruited as the controls, and preserved practically complete immunity from attack by the mite. The control plant was already severely infested 4 days after infection.

(*ii*) August 23rd.—Soil of pots watered with 500 ccs. of a 0·015% solution: six plants 12–16 inches high. Three days after treatment some injury to a few leaves upon the lower branches was observed but after this the plants grew and fruited as the controls. The plants were slightly infested with mites before treatment. A number of eggs were found upon leaves on August 29th, but no attack developed, and on September 18th, feeding marks of the mite occurred sparingly only upon the lower four or five branches of each plant; the upper five or six branches were entirely free of mites or their eggs. Two control plants had already become severely infested on August 29th, and on September 18th. Mites with their eggs were plentiful up to the topmost branches.

(*iii*) At the end of September and beginning of October, pots of a considerable number of plants, ranging in height from 8 to 14 inches were heavily watered once with solutions of concentration between 0·1% and 0·015%. With 0·015%, very slight initial injury to the lower branches occurred, and the plants afterwards grew normally; with 0·03% and 0·05% the initial injury was generally more severe, but recovery was made; with 0·075% and 0·1% permanent injury was sustained. All the plants shewed a high degree of immunity from mite attack until and after November 12th.

(*c*) *Plants treated in 9-inch pots.*

August 21st.—Soil of pots given 300 ccs. of 0·1, 0·05, and 0·033% solutions respectively; plants 20–22 inches high, and severely infested at the time of treatment. Foliage was uninjured and the plants grew and fruited as the controls.

With 0·1%, young stages of the mite were found to be dying on the 7th, and older stages on the 9th day after treatment, but many eggs were still present; on September 5th few eggs were found, and only recently hatched larvæ were alive. The plants remained practically free of mites until and after October 15th.

With 0·05%, some dead larvæ were found on the 5th day, but some older stages were still living and a number of eggs were present on the 15th day after treatment. Subsequently the plant became practically free of the mite.

With 0·033%, some larvæ but only few of the older stages were alive on September 19th, but eggs were not numerous. Some eggs and living mites were still present on October 15th.

From the above observations it would appear that development of mite attack was prevented, or that mites already upon the plants before treatment were killed off in the great majority of cases by

thoroughly watering plants in the "60" pot stage with a 0·015% solution of sodium selenate. At this dilution, injury to the plant occurred only in the case of weak plants which had outgrown their pots at the time of application.

It was estimated that the weight of soil in a "60" size pot is about 12 ounces, and that this amount of soil absorbed about 75 cc. of liquid. Therefore, the amount of sodium selenate necessary to secure immunity from attack with little risk of injury to the plant probably lies between 30 and 40 parts per million parts soil. Somewhat similar results were obtained with larger plants in "32" size pots, but proportionately larger quantities of the selenate could not be applied without some risk of injury; individual plants however, were completely immunized from attack without injury to the plant with concentrations as high as 74 parts per million. Two plants, severely infested with mites before treatment and growing in 9-inch pots, the soil of which contained respectively 37 and 74 parts per million threw off the attack and remained practically immune for the remaining period of their growth. The mite attack upon another plant in soil which was computed to contain about 25 parts per million, was only partially held in check.

No explanation can at present be offered as to the reason why new growth of a plant should develop immunity from attack after comparatively small quantities of sodium selenate have incorporated with the soil. Although the experiments are of no practical value to the grower, owing to the danger of incorporating selenium with the soil, it still remains to be seen if immunity from attack can be obtained by treatment of seed; experiments now in progress shew that seeds which have been soaked in a solution as strong as 2% will germinate as quickly as untreated seed, and the results of the experiments already carried out with growing plants will serve as a valuable guide in future work.

2. Tomato Moth.

E. R. Speyer.

Moth trapping

In our Annual Report of 1919, Dr. Ll. Lloyd, referring to the use of treacle as an attractant in moth jars, in conjunction with ale and sodium fluoride, suggested the replacement of treacle with the cheaper, but then unprocurable, "thick dark molasses." It is now only the latter substance which could be employed under present conditions. Samples of both Cane and Beet Molasses were kindly supplied by the British Sugar Corporation Ltd., for experimental purposes. Owing to various exigencies, a comparison of the effectiveness or otherwise of these two forms of molasses with that of treacle could not, in larger scale experiments, be made exactly over the same period, but this object was achieved relatively by hanging the

jars in houses at the Experimental Station soon after the respective blocks in each case were first heated up in spring. Small-scale experiments carried out concurrently at a later date, when moths were few, gave confirmatory results.

In the larger scale experiments, 2 fluid ounces cheap ale, 1 fluid ounce of the substance to be tested, and sodium fluoride to the amount of 1%, were placed in each jar, and the jars hung in the houses, with periodic removal of the ingredients, over a period of 40 days.

Houses	*No. of Jars*	*Period (40 days)*	*Attractant*	*Moths trapped*		
				Male	*Female*	*Total*
2	16	21. II-2. IV ...	Treacle ...	12	22	34
3	12	21. III-30. IV ...	Cane molasses	29	56	85
3	12	do. do.	Beet molasses ...	9	12	21

In the cases of the two forms of molasses, the position of the jars was interchanged periodically. The small-scale observations were made in a single house of a block and ran concurrently.

Ingredients	*No. of Jars*	*Period in days*	*Moths trapped*		
			Male	*Female*	*Total*
Treacle 1 part, Ale 2 parts ...	4	14	2	1	3
Cane molasses 1 part, Ale 2 parts	4	14	—	5	5
,, ,, ,, ,, ,,	8	8	4	2	6
Cane molasses 1 part, Ale 3 parts	8	8	4	6	10

It was concluded that Cane molasses was at least as attractive as Treacle and that Beet molasses, tested concurrently with it was less so. It was also noted that the mixture of 2 parts ale with 1 part Cane molasses dried up quickly, and that an increase in the proportion of ale to 3 parts was more satisfactory. The practice of hanging moth jars from the wires in tomato houses appears to be falling into disrepute, and it cannot be too strongly emphasized, as it was years ago by Dr. Lloyd, that this method of control is essential as an adjunct to spraying early in the season with lead arsenate, if severe infestations upon nurseries are to be avoided.

In experiments to determine if a more effective poison than sodium fluoride is obtainable, moths immediately after emerging from the chrysalids were kept in cages and allowed to feed upon a

mixture of ale and Cane molasses containing varying percentages of sodium fluoride, sodium arsenite, and thallous sulphate. A tomato plant was introduced into each cage to record the deposition of egg-masses. Though a considerable number of moths died after feeding upon baits containing 0·1%, and especially 0·25% sodium arsenite, large egg-masses were deposited upon the foliage before the moths succumbed; thallous sulphate at the one concentration tested (0·6%) was without effect on the moths; with sodium fluoride a high percentage of moths, over periods of 2–4 days, were killed, and very few eggs were laid.

3. Root-Knot Eelworm.

Experiments have been started with a view to determining the effect of watering the soil in which tomato plants are grown with potassium iodide solution, as a means of control for *Heterodera marioni* Cornu. On September 4th, the soil of 9-inch pots in which plants 5 to 8 inches high had been planted, was watered respectively with 50, 100, 250 and 500 cc. of potassium iodide at a dilution of 1 part in 2,000 parts water. Portions of noduled roots and infected soil had previously been introduced into the pot-soil.

Plants treated with 500 cc. were very severely, and those with 250 cc. slightly injured; at the two lower applications the plants grew as the untreated controls.

Examined two months after treatment, the roots of all the plants bore large numbers of nodules, except for the almost dead plant, roots of which were brown and almost functionless.

Experiments with repeated applications, as practised by some growers with apparent success in certain types of soil are in progress.

4. Wireworm Control.

E. R. Speyer.

In May, plots of each of 1 square yard were measured out in a tomato house; in each plot six tomato plants 17 to 20 inches high were growing, with the first truss in flower or set.

Mixtures of dichlorethyl ether and water respectively in proportions of 1 : 250, 1 : 500, and 1 : 1,000 were applied to the plots, 5 gallons of each being given to three, and 2 gallons of each to three plots. Two control plots were given proportionate quantities of water.

In all the treated plots, the foliage of the lower branches had turned yellow and the plants flagged by June 6th. These plots were replanted in mid-July but the new plants shewed symptoms of severe injury after growing in the soil for a short period of time.

It is therefore unlikely that dichlorethyl ether would be safe to use as a means of controlling wireworm.

5. Angle-Shades Moth.

E. R. Speyer.

At the beginning of April eggs were obtained from a female moth; these were laid singly or in batches of two or at most three, both on the upper and lower surface of chrysanthemum and geranium leaves. Caterpillars from these eggs were kept under observations, the number of their moults recorded, and the moths were finally bred to maturity the end of June or in early July. An account of the life-history is being published in the Annals of Applied Biology.

5. Chemical Problems.

O. Owen.

The first full year under war-time conditions has seen a definite increase in the number of samples of various kinds submitted for examination. Chief among these have been soils, many from growers using the Station for the first time, and materials offered to growers in place of the standard fertilizers.

Owing to the restricted supplies of potash available many growers have considered the use of charcoal and wood ashes. There is no doubt that considerable amounts of potash exist in the form of plant ash and growers are advised to consider burning for themselves any waste vegetable matter at their disposal. In this connection it is important to emphasize the necessity of protecting both the material and its ash from rain and snow. Exposure invariably leads to considerable losses of the potash. This is exemplified by two samples of so-called bracken ash examined by us. In both cases the amount of potash present was so low that it did not pay for the cost of burning. This we are convinced was due to the fact that the bracken and subsequent ash had been exposed to heavy falls of rain which washed away the potash. Bracken ash is well known to be a rich source of potash at certain times of the year and where supplies are available should be used more frequently.

Several samples of charcoal which have been analysed shew potash contents varying from 0·6% K_2O to 16·08%. These draw attention to the need for growers to consider very carefully whether they are receiving value for money. In spite of fluctuations in prices of standard products there still exists a definite relation between price and manurial content. In one case a grower was asked £12 per ton for a product which could not possibly be assessed as being worth more than 30*s.* per ton on the basis of prices then prevailing. Examples of this kind could be multiplied and include nitrogenous as well as potassic materials.

One query which has been raised repeatedly concerns the purity and value of the so-called "organic" sulphate of potash. This is usually brown in colour and growers who see it for the first time question the safety of its use and purchase. It may be said that this material has been used for years and is just as suitable as the commoner white or yellow varieties. Generally speaking, this organic sulphate of potash contains rather more pure potash than do the more usual forms.

The possibility of using muriate of potash or potash salts in the place of sulphate made it necessary to compare the effects of these substances on plants. Unless the soil contains excessive amounts of salt there is no reason why the muriate should not be used in place of sulphate. With regard to potash salts however,

the position is not so satisfactory. When used on pot plants in some preliminary trials potash salts caused a considerable amount of yellowing of the lower leaves which soon died off. Later, more critical experiments were initiated to determine the reason for these effects. Unfortunately the glass of the house used was broken and the low temperatures checked the plants so severely that it was impossible to make any useful observations. It is hoped to repeat the experiments next spring. Meanwhile we are unable to advise the use of potash salts on tomatoes.

A rather unusual query concerned the possible beneficial effect of a sample of fireclay on plant growth. The particular sample was part of an outcrop on which grew particularly good wild roses. This was difficult to understand as the material was almost completely insoluble in water and analysis shewed it to contain rather more alumina than is usual. It was tested at the Station both on wild roses and tomatoes but we were unable to find that the plants reacted in any way.

Thanks to the generosity of Roche Products Limited, who placed a sample at our disposal, it has been possible to examine the effect of pure Vitamin B_1 on tomatoes and chrysanthemums. It has been claimed that very small amounts of this vitamin stimulate plant growth. Varying amounts were applied to tomatoes at the time of sowing and at later stages. It was always found that some acceleration of germination followed the application of very dilute solutions to the propagating soil. Subsequently the seedlings so treated were larger than corresponding untreated seedlings. When these were potted however, the difference soon disappeared despite continual application of the vitamin. Applications of solutions of varying strength to plants already potted and in different stages of growth were, generally speaking, without any apparent effect. Similar experiments were made on chrysanthemum, Market Gold, and again there was no effect. It is concluded that if this vitamin is necessary for plant growth the composts used here for tomatoes and chrysanthemums contain adequate amounts of it.

The increasing use of peat in intensive horticulture has meant that we are often consulted about the desirability of various samples. It would appear that peats of varying acidity can be used successfully. At the same time it is often difficult to decide whether or not any one sample should be used. Accordingly a series of experiments are now in progress as the result of which it is hoped that some reliable method for the evaluation of peat will be evolved.

6. Miscellaneous.

1. The Effect of Creosote and Petrol Vapours on Mushrooms.

W. H. Read.

During the winter of 1939–40 a peculiar distorted woody condition of mushrooms caused serious loss in some large mushroom houses. The stems of the mushrooms were greatly enlarged; the caps in many cases were small and had split; gills were practically non-existent. The bed boards and superstructure of the house had been treated with a mixture of equal parts of creosote and petrol and it was thought that either creosote or petrol fumes might be responsible for the injury. Experiments were made on portions of the beds in the mushroom house at the Research Station using several samples of creosote with and without the addition of petrol, in an attempt to reproduce the trouble. Varying amounts of creosotes, and also tar acids and neutral oils isolated from creosotes, both alone and mixed with equal parts of petrol were placed in inverted bell-jars covering portions of the bed in which the first flush of mushrooms was appearing. In other experiments very small amounts of these mixtures were sprayed upon the casing soil and also upon the top of the compost before casing. In none of these experiments was distortion caused similar to that under investigation.

In many cases the young mushrooms were killed and occasionally where the amount of the substance applied was small the caps of white mushrooms were browned. The order of toxicity was creosote acids, creosote, creosote neutral oils and petrol.

Mushrooms grown from mycelium taken from the beds where distortion was occurring were normal and although the production of mushrooms was delayed and reduced in some experiments with casing soils similar to that used where the trouble was occurring, no distortion occurred.

Other mushrooms were grown in frames in which pieces of wood freshly treated with creosote and petrol-creosote mixtures were placed. Although the fumes from these destroyed young newly-formed buttons no distortion was caused and as the concentration of vapours became less, perfectly formed mushrooms grew normally. Mushrooms grown in boxes painted with creosote immediately before placing the compost in them and spawned — days later were normal.

The results of these experiments do show, however, that creosote fumes are injurious to mushrooms if present in sufficient concentration. In normal practice most of the volatile fractions of creosote will have disappeared from the woodwork before the spawn is inserted in the beds and damage to the mushrooms is unlikely to occur. Dipping the bed boards in a bath of creosote adds to the risk owing to the greater amount which will be absorbed by the wood than if the boards are painted. Obviously the internal structure must not be creosoted when the beds are cropping. Probably the risk is increased if the temperature of the house remains low from any cause including failure of the compost to heat up after being made into beds.

2. Plant Injury due to Sodium Carbonate in a Nursery Water Supply.

W. H. Read.

Serious injury to foliage of cucumber, tomato and beans had occurred on an Essex nursery for many years and the presence of some injurious substance in the water supply used for spray fluids for "damping" the plants overhead was suspected. Samples of the water obtained from a deep bore well had been analysed, however, and stated to be free from injurious substances. When Mr. Orchard visited the nursery to inspect the damage he still suspected water injury and collected a sample for investigation.

The foliage symptoms were similar to those found on plants which have been scorched by strong fumes. Dead areas irregular in shape were prevalent on the leaves and near the growing point the foliage was distorted through the death of the leaf edges.

Experimental proof that the water was responsible for the injury was obtained by spraying young cucumbers repeatedly with the water obtained from the nursery. Chemical analysis of the water provided no evidence of pollution with surface drainage and tar acids, chlorates, heavy metal salts, etc., known to be highly injurious to plant were absent. Sodium carbonate (soda) and sodium chloride (salt) were the only substances present in appreciable amounts, viz. 51 parts per 100,000 and 43 parts per 100,000, respectively. Sodium chloride is present in greater amounts than this in the water on several nurseries where no damage has occurred but the sodium carbonate was abnormally high.

Young cucumber plants were sprayed three times with distilled water solutions containing (*a*) 51 parts of sodium carbonate in 100,000 parts water, (*b*) 43 parts sodium chloride in 100,000 and (*c*) 51 parts of sodium carbonate plus 43 parts of sodium chloride in 100,000. Damage was caused by (*a*) and (*c*), the damage from (*c*) being slightly more severe than that from (*a*) and equal in severity to the damage caused by an equal number of applications of the water from the nursery.

It is seen, therefore, that the presence of sodium carbonate in amounts of 51 parts in 100,000 parts water, approximately equivalent to 1 ounce of washing soda in 4 gallons, will cause injury if sprayed on the foliage of cucumbers, tomatoes and beans under glass, and the injury is more severe where there are relatively large amounts of salt. The removal of sodium carbonate from the water would have been difficult, consequently an alternative source of supply was arranged at the nursery and no injury to the plants has occurred since water from the new supply has been used for overhead damping.

The ability of the Thanet sand, from which the water is obtained, to act like the material in salt regenerated "base exchange" water softeners gives a possible explanation for the presence of sodium carbonate in the water. The calcium carbonate dissolved by water when passing through chalk is replaced by sodium carbonate when it percolates through the sand. This "softening" action of the Thanet sand is maintained by the admixture of some sea water with the water which has percolated from the surface. The presence of sea water is indicated by the amount of salt found in the water from the well.

3. Experiments on the Treatment of Glasshouses to Reduce their Visibility from the Air.

W. H. Read.

When hostilities commenced the problem of camouflaging buildings to make them less easily detected from the air, assumed great importance and experiments were made to see if glasshouses could be camouflaged or, if this should prove impractical, if the roofs could be treated to prevent the reflection of light from them.

The recommended method of camouflaging large glass roof lights was to apply a coat of varnish and sprinkle coloured sand on it while wet and, as the result of official requests, this was done to a roof of one of the glasshouses at the Research Station. As was expected this method was impractical since the intensity of the light within the treated house was reduced to about a quarter of that in an untreated house. Other trials in which the glass was sprayed with flour and starch "shadings" containing brown and green pigments, brown and green distempers, brown matt varnishes and a number of products submitted by manufacturers, all showed that it was impossible to effectively camouflage glasshouses without the loss of at least 45% of the light. It is obviously impossible to produce food crops in glasshouses under such conditions. Methods for the elimination of reflection or "glare" from the roofs of glasshouses were therefore tried, but also proved impractical since at least 20% of the light which would normally enter the house was lost if the reflection was sufficiently reduced to prevent "glare." The ordinary flour paste shading consisting of two pounds of flour in two-and-a-half dozen gallons of water caused a loss of 22% of the

light when applied in sufficient quantity to eliminate reflection. A proprietary product, the composition of which is unknown, gave the most satisfactory result for when applied to the glass it dried to form an almost colourless matt surface which caused the loss of only 15% of light.

A loss of one-fifth of the available light would cause greatly reduced crop yields and the authorities decided that the camouflaging or prevention of glare from glasshouses would be required only in exceptional circumstances.

Without an adequate knowledge of the principles of camouflaging and the degree to which reflection must be reduced it was difficult to decide whether the various treatments would be satisfactory. The problem of disguising buildings so that they cannot be readily detected from the air has been subjected to much careful study by experts since these trials were made, and many of the original methods adopted for camouflaging buildings have been discarded. In all probability shading with a mixture of flour, or starch and whiting to eliminate glare would increase the ease of detection of the houses at times, on account of their whiteness. The treatments considered ineffective for the elimination of glare are indicated.

It was found that treatments containing solid material in suspension tended to flow so that areas were almost free from deposit. Grime adhering to treated glass surfaces still further decreased the light transmitted.

Treatment	Light Reduction	
	Bright Sunlight	Dull
Varnish—1 gallon to 550 square feet, dusted with ordinary sand (6 lbs. per 100 square feet) ...	55-57%	50%
Varnish (as above) dusted with coloured sands ...	80%	60%
Flour paste (1 lb. flour in 1 gallon cold water) and green pigments (6 ozs. per gallon)	48-58%	—
As above but 8 ozs. pigment per gallon	55–72%	—
Flour paste and clay suspension	50%	—
Linseed oil emulsion and clay suspension	54%	—
Washable distempers—green	48–70%	—
Brown non-glint lacquer No. 1	68%	50%
Brown—lacquer No. 2	65%	52%
Flour paste (1 lb. flour in 1 gallon cold water)	17–25%	15%
*Flour paste (1 lb. flour in 1 gallon boiling water) ...	8%	7%
*Flour paste ($\frac{1}{2}$ lb. flour in 1 gallon boiling water) ...	5%	5%
*Starch paste ($\frac{1}{4}$ lb. starch boiled in 1 gallon water) ...	8%	—
Starch paste and whiting (1 part starch, 4 parts whiting)	28%	—
Starch paste and brown and green pigments	51 27%	—
Proprietary anti-glare emulsion 10% dilution	15-25%	—
Proprietary anti-glare emulsion 20% dilution	38%	—

* Insufficient elimination of glare.

4. Further Experiments on the Vernalization of Tomato Seeds.

D. W. Goodall and B. D. Bolas.

The results of the tomato vernalization trials in 1939 have now been computed. In the experiments of the previous year it had been found that chilling after germination had begun tended on the whole to retard development. There were, however, promising results from a couple of isolated experiments in which the moist seed was chilled before germination. This line of experimentation was followed in 1939.

Once again seed of the variety Potentate was used; the seeds were spread in covered petri dishes on moist filter paper, and one batch of petri dishes was placed in an ice bath. Three others were put in refrigerators, the mean temperatures of which during the period of treatment were 2·5° C., 7·0° C. and 9·5° C. Some seeds were given ten days' chilling, others twenty days. All the petri dishes were then transferred to an incubator at 14° C. the filter papers being remoistened so that they were saturated with water, but there was no excess. Control dishes of moist seed were placed in the incubator at the same time. The petri dishes in the incubator were left open, together with a large dish of calcium chloride. After four days half the petri dishes from each temperature treatment and from the controls were remoistened and covered, while the other half were left to dry slowly, the calcium chloride being removed. Four days later, when germination had begun, all the dishes were removed from the incubator; those which had been left open for eight days were almost dry.

On December 30th, 1938, the seedlings from the petri dishes were planted individually in the seed boxes, forceps being used to avoid damage. The young plants were potted and later planted out in the greenhouse in the usual way. The house was divided into four blocks, each with twenty-four rows of five plants. Of these rows, one was of plants of each of the sixteen treatments and four from each of the two controls.

Though a severe attack of mosaic disease led to the loss of a number of plants, and thus complicated the statistical analysis, it is possible to state definitely a number of results. The plants chilled before germination produced a larger crop than those not so chilled, and the twenty-days treatment gave better results than ten days. The four different temperatures of chilling used have differed little in their effect, and the two humidity conditions during germination hardly affect the behaviour of the plants at all. The mean yields through the season (unripened fruit not gathered) are given in the table below in pounds of fruit per plant, together with the percentage increased over the control.

	Control	*Ten days*	*Treatment increase*	*Twenty days*	*Treatment increase*
	lb.	*lb.*	%	*lb.*	%
Up to June 19 ...	0·42	0·52	24	0·61	45
June 20 to July 5	1.06	1·06	0	1·08	2
July 6 to July 19 ...	1·32	1·46	11	1·46	11
July 20 to Aug. 2...	1·42	1·42	0	1·52	7
Aug. 3 to Aug. 18	1·04	1·05	1	1·10	6
Aug. 19 to Sept. 8	1·33	1·19	11	1·39	5
Sept. 9 to Sept. 27	1·16	1·33	13	1·47	27
Total ...	7·75	8·03	4	8·63	11

It will be noted that the percentage increase in crop is particularly marked in the first few weeks.

It would be an advantage if similar experiments could be carried out under different conditions and with other varieties.

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APPENDIX B.

Manurial Treatment in Tomato Experiments.

(Except plots in Appendix C.)

(1) Lime.

All houses received ground caustic lime at the rate of 1 ton per acre.

(2) Stable Manure.

Stable manure at the rate of 15 tons per acre applied to all houses except :—

House 4, plots 5 and 6; house 5, plots 1, 2 and 4; and house 10, plots 2 and 4.

(3) Base-dressing.

All houses received ½ ton hoof and horn, ½ ton bonemeal, and ½ ton sulphate of potash per acre except house 3, plots 2 and 4; house 4, plot 5; and house 5, plots 1, 2, 3 and 4. House 7, plots 2 and 4; house 8, plots 1 and 3; and house 9, plots 1 and 2, received ½ ton muriate of potash per acre instead of sulphate of potash.

(4) Top-dressing.

SULPHATE OF POTASH.—All houses received a first top-dressing of sulphate of potash at the rate of 5 cwts. per acre.

FERTILIZER MIXTURE.—All houses except plots 1, 2, 3 and 10, 11 and 12, house 4, received 5 cwts. per acre of the following mixture every fourteen days at discretion :—

3 parts sulphate of ammonia.
2 parts dried blood.
7 parts 30% superphosphate.
5 parts pure dissolved bones.
½ part bone flour.
2½ parts sulphate of potash.

All houses received three top-dressings of the following mixture at the rate of 5 cwts. per acre :—

1 part sulphate of ammonia.
1 part nitrate of potash.
3 parts superphosphate.
5 parts dried blood,

except house 5, plots 2 and 4, and the muriate of potash plots in houses 7, 8 and 9, where muriate of potash was given instead of sulphate of potash.

Appendix C.

Manures applied to Plots 1-3, and 10-12 in Tomato House 4.

Plot.	TITLE.	Base Manure in Lbs. per sq. yd.				* Top-dressing in Lbs. per sq. yd.			
		Lime.	Stable Manure.	Basic Slag.	Sulphate of Potash.	Super-phosphate.	Sulph. of Ammonia.	Nitrate of Soda.	Sulph. of Potash.
1	Complete Artificials (I.) without Nitrogen	1.0	—	0.4	0.1	0.5	—	—	0.2
2	Unmanured	1.0	—	—	—	—	—	—	—
3	Complete Artificials	1.0	—	0.4	0.1	0.5	0.2	0.2	0.2
10	Complete Artificials with Dung	1 0	7	0.4	0.1	0.5	0.2	0.2	0.2
11	Complete Artificials without Phosphates	1.0	—	—	0.1	—	0.2	0.2	0.2
12	Complete Artificials without Potash	1.0	—	0.4	—	0.5	0.2	0.2	—

* The Top-dressing was applied in eight equal instalments.

Appendix D.

Dates of Cultural Operations, 1939—1940.

Crop.	Sown.	Potted into 60's.	Planted out in borders.	First Top Dressing.	First Fruit Picked.	Last Fruit Picked.
Tomatoes ...	Dec. 14 1939	Jan. 16 1940	Mar. 3 1940	May 6 1940	May 17 1940	Oct. 25 1940

Meteorological Records, 1940.

Month.	Air Temperatures						Grass Temp.			Rainfall				Mean Soil Temperatures		Hygrometer				Bright Sunshine		Barometer
	Mean		Absolute Max.		Absolute Min.		Av. Min.	Absolute Min.		Total Precipitation	No. of Days P'ptn.	Greatest Fall				Dry Bulb	Depres. of Wet Bulb	Relative Humidity %	Dew Point	Total No. of Hrs.	Daily Average.	
	Max.	Min.	Tem.	Date	Tem.	Date		Tem.	Date			Amt.	Date	1 ft.	2 ft.							
	°F.	°F.	°F.		°F.		°F.	°F.		Ins.		Ins.		°F.	°F.	°F.	°F		°F.			Ins.
January	35.9	23.8	49.0	6th	10.0	19th	20.9	5.0	19th	1.47	4	0.58	29th	33.6	35.4	29.4	0.6	90.5	26.9	66.5	2.22	29.98
February	41.6	31 0	54.0	22nd, 24th, 26th, 29th	20.0	12th	29.2	18.0	12th	3.45	9	0.90	7th	34.4	35.9	36.6	0.3	96.1	35.6	28.0	0.96	29.86
March	52.4	35.2	63.0	11th	12.0	21st	34.4	9.0	21st	3.15	6	1.10	25th	40.4	41.7	44.5	1.7	88.0	40.9	123.5	3.98	29.95
April	49.0	40.1	71.0	21st	28.0	7th	37.5	29.0	7th, 17th	1.31	6	0.50	19th	47.2	48.7	49.7	1.8	87.4	46.1	89.4	3.74	23.83
May	68.4	43.2	75.0	24th	35.0	6th, 11th	40.5	29.0	6th, 11th	1.94	5	1.07	21st	55.1	56.9	59.9	3.3	80.7	53.7	221.8	7.16	30.05
June	76.2	49.5	86.0	9th	44.0	9th	46.7	40.0	29th	0.56	4	0.23	8th	63.5	63.6	65.3	5.5	71.9	55.3	289.3	9.64	30.15
July	71.0	51.7	82.0	2nd	45.0	4th	49.8	41 0	27th	2.13	12	0.50	16th	61.5	61.7	64.6	5.5	70.7	54.5	224.7	7 25	29.93
August	72.5	49.9	83.0	18th	38.0	23rd	46.0	32.0	23rd	0.04	2	0.02	20th, 21st	58.3	58.3	65.7	5.2	71.8	56.3	226.0	7.29	30.20
September	68.7	44.4	87 0	4th	32.0	25th	39.9	28.0	25th	0.65	5	0.30	19th	57.6	57.8	60.2	4.5	75.2	51.7	206.5	6.88	30.04
October	58.3	41,8	64.0	27th	24.0	29th	38.1	21.0	29th	2.33	6	0.95	23rd	49.8	51.1	51.5	1 1	92.6	49.6	123.6	4.94	29.92
November	51.0	38.0	59.0	4th	24.0	30th	33.8	21.0	29th	6.21	12	1.15	13th	45.5	45.5	45.8	1.3	89.7	44.0	65.9	2.20	29 89
December	44.0	33.8	52.0	16th, 30th	22.0	12th	31.2	19.0	12th	1.51	10	0.41	14th	40.1	40.5	39.3	0.9	92.6	37.3	26.2	0.85	30.12

Total rain for year, 24.75 ins. No. of days precipitation, 81. Total bright sunshine for year, 1691.4 hours.

DIAGRAM SHEWING ARRANGEMENT OF EXPERIMENTAL PLOTS, 1940